General Report
on the
Operations of the Survey of India
under the Government of India
1878-79 to 1880-81

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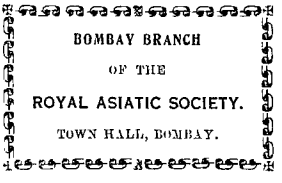

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GENERAL REPORT

ON THE

Operations of the Survey of India,

COMPRISING

THE GREAT TRIGONOMETRICAL, THE TOPOGRAPHICAL, AND THE REVENUE SURVEYS UNDER THE GOVERNMENT OF INDIA

DURING

1878-79.

134595

PREPARED UNDER THE SUPERINTENDENCE

OF

MAJOR-GENERAL J. T. WALKER, C.B., R.E., F.R.S., &c.,
SURVEYOR-GENERAL OF INDIA.

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INDIA
To 1st October 1878.
ARABIAN
SEA
BAY
OF
BENGAL
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GENERAL REPORT

ON THE

Operations of the Survey of India

FOR SEASON

1878-79.

INTRODUCTORY.

THE Annual Report of the Survey of India for the Survey year 1877-78 describes the amalgamation of the three separate and independent Survey Departments under the Government of India—long known as the Great Trigonometrical, the Topographical, and the Revenue—which had been effected on the 1st January 1878; it also explains the reasons why that measure had become necessary. Thus the present annual report is the second of the amalgamated department, now known as the Survey of India.

2. The amalgamation has been effected with less of remonstrance and difficulty than might have been anticipated. The prospects and interests of almost every member of the Survey have been more or less injuriously affected; but the complainants have been few; and there has been a general consension of opinion that the measure was necessary and unavoidable in the interests of the public service, and that it could not well have been postponed much longer. It was made partly with the object of facilitating the carrying out of certain reductions of establishment which the exigencies of the service necessitated, and which might be made to fall more evenly and equably on the several individuals in the three branches of the department, after the amalgamation, than would have been possible if the three separate lists had been maintained, as formerly. In the report for last year a hope was expressed that some provision might be made shortly, by the grant of personal allowances, to compensate the officers who had been most injuriously affected by the reorganization, for their deteriorated prospects. Unfortunately, however, this has not as yet been found possible; but, on the contrary, further reductions, diminishing the number of officers and surveyors by one-sixth below the reduced scale which had been laid down only so recently as in February 1878, were ordered in June 1879, and are now being carried out by degrees, as opportunity offers.

3. Under the recent instructions, all officers whose services can be conveniently dispensed with, are permitted, if they have completed the necessary term of service for pension, to retire on a pension; otherwise they will be put on half pay, with permission to accept employment elsewhere until such time as their services may be again required. The time spent on half pay is allowed to count as service towards pension, up to five years, at the end of which, retirement or transfer to some other department will be compulsory, should re-employment in this department be impossible.

4. On the 31st December 1878, Major-General Vanrenen, R.A., Deputy Surveyor General and Superintendent of Revenue Surveys, was permitted to resign his appointment and retire to Europe. He had spent 39 years in the service of the Indian Government, of which no less than 32 had been passed in the Revenue Survey Department. On the occasion of the separation of the duties of that branch of the Survey into two circles, in the year 1866, he was appointed Superintendent of the Lower Circle; and subsequently, on the reunition in 1876, he became Superintendent of the whole of the Revenue Surveys. He has left behind him many evidences of valuable work which had been carried out under his supervision—first, as an Executive Officer, and afterwards as the Administrator of a large department.

5. Major (now Lieutenant-Colonel) Sconce was appointed to succeed General Vanrenen as Deputy Surveyor General. The direct supervision of the Revenue Survey parties at present rests with the Deputy Surveyor General, and that of the Trigonometrical and Topographical Surveys with the Surveyor General, and this arrangement must continue until the head-quarters offices, which are now in separate buildings in different parts of Calcutta, can be brought under one roof, as has long been contemplated;—a site for the new offices has been purchased, and the designs are nearly completed; but the building is not yet commenced, and there is little probability of its being completed for some years. Even under existing conditions, however, there is much more of mutual co-operation between the three branches of the Survey Department than was possible before the amalgamation; this has been more particularly evinced in the topographical operations in Afghanistan, in which officers and surveyors, both European and Native, from the three branches, have been employed indiscriminately.

6. The principal Operations of Survey which have been carried out during the year under review, embracing the period from 1st October 1878 to 31st September 1879, are as follows:—

Statement of Survey Operations and Parties.

Number in this Report.	Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party.	Remarks.
	Triangulation.			
I.	Madras...	Lt.-Col. B. R. Branfill ...	Madras Party ...	Principal Triangulation.
II.	Tavoy and Siam ...	Capt. J. Hill, R.E. ...	Eastern Frontier Party	Secondary Triangulation.
III.	Western Sind and Beluchistan.	.....		
IV.	Burma	Mr. W. G. Beverley ...	Burma Party ...	
	Topography.			
V.	Central India ...	Capt. C. Strahan, R.E. ...	No. 1 Topogl. Survey	Topography on 1-inch scale, for reproduction on same scale.
VI.	Kandesh	Mr. H. Horst	No. 2 „ „	
VII.	Malwa	Major J. R. Wilmer, S.C. ...	No. 5 „ „	
VIII.	Sylhet	Major W. F. Badgley, S.C. ...	No. 6 „ „	
IX.	Rajputana	Lt.-Col. G. C. Depree, S.C. ..	No. 7 „ „	
X.	Mysore	Major H. R. Thuillier, R.E. ...	No. 8 „ „	
XI.	Guzerat (Bombay) ...	Lt.-Col. C. T. Haig, R.E. ...	Guzerat Survey ...	2-inch scale, for reproduction on same scale and reduction to 1-inch scale.
XII.	Meerut Division, N. W. P.	Major W. H. Wilkins, S.C. ...	3rd Revenue Survey...	
XIII.	Kattywar	Major A. Pullan, S.C. ...	Kattywar Survey ...	2-inch scale, for reduction to 1-inch scale.
XIV.	North Deccan ...	Colonel J Macdonald, S.C. ...	10th Revenue Survey	
XV.	South Deccan ...	Major H. S. Hutchinson, S.C....	11th „ „	
	Mouzawar or Village Survey.			
XVI.	Rawal Pindi and Dera Ismail Khan.	Capt. H. Lees Smith, S.C. ...	1st Revenue Survey	4-inch scale.
XVII.	Sirsa and Jhelum ...	Lt.-Col. D. Macdonald, S.C. ...	2nd „ „	
	Cadastral or Field Survey.			
XVIII.	Banda and Mirzapur ...	Colonel F. C. Anderson, S.C. ...	5th Revenue Survey	16 inch scale, and Forest Survey on 4-inch scale.
XIX.	Jaunpur	Mr. E. T. S. Johnson ...	6th Revenue Survey	16-inch scale.
XX.	Budaon and Ghazipur ...	Major W. Barron, S.C. ...	4th „ „	
XXI.	Khorda Estate, Orissa ...	Mr. B. B. Smart	7th Revenue Survey	32-inch scale.
XXII.	Cuttack	Mr. H. B. Talbot ...	9th „ „	
XXIII.	Cachar	Major S. H. Cowan, S.C. ...	8th Revenue Survey	16-inch scale.
XXIV.	Barkagarh	Mr. J. Campbell ...	(Half Party) ...	
XXV.	Burma	Captain J. E. Sandeman, S.C....	Hanthawaddy Survey	
	Miscellaneous.			
XXVI.	Kamrup	Mr. W. H. Patterson ...	Lakhiraj Survey ...	Detached estates on 8-inch scale.
XXVII.	Darjeeling	Lieut. H. J. Harman, R.E. ...	Darjeeling Survey ...	Detached estates, various scales.
	Geographical.			
XXVIII.	Afghanistan	.....	.....	
XXIX.	Trans-Himalayan Explorations	.....	.....	
XXX.	Surveys around Gilgit ...	.....	.....	
	Tidal and Leveling.			
XXXI.	Bombay and Madras ...	Capt. A. W. Baird, R.E. ...	Tidal and Leveling Party.	
	Geodetic.			
XXXII.	Southern India ...	.....	.....	

These operations will be described in detail in the order in which they are given above, in the subsequent pages of this report; but a few remarks may be here offered regarding the general progress of the Survey.

7. The Principal Triangulation of all India has now so nearly approached completion—on the lines originally laid out for it by Colonel Everest with the approval of the Court of Directors of the Hon'ble East India Company—that only one party was employed on it during the present year; two others, which had been thus employed in the preceding year and still had each a season's work to complete, have been temporarily withdrawn, in order to execute the secondary triangulations connecting Siam on the one hand and Southern Afghanistan on the other, with the principal triangulation. Of the two parties which had been employed in secondary triangulation in the preceding year, the one in Assam, having completed its work in that district, was transferred to Darjeeling to carry out a variety of miscellaneous surveys required for the Revenue and Settlement Department and the Darjeeling Municipality; the other party remained in Burma, working in continuation of its operations of the preceding year. The general out-turn of the triangulation was as follows:—A chain of principal triangulation—77 miles in length, furnishing 17 new stations and checked by 2 astronomical determinations of azimuth—which embraces an area of 1,120 square miles, and fixes 40 secondary points in and around that area; also chains of secondary triangulation of an aggregate length of 256 miles, fixing 377 points in an area of 3,200 square miles.

8. The regular Topographical Operations—mostly on the standard scale of one inch to the mile, and the enlarged scale of two inches to the mile—were carried on in continuation of the operations of the preceding year, in the same districts, and by the same parties, with the exception of the Kumaun and Gurhwal Survey, which had been completed and the party broken up. The general out-turn of the topography was as follows:—

5,424 square miles surveyed on the ½-inch scale.
8,778 square miles surveyed on the 1-inch scale.
9,179 square miles surveyed on the 2-inch scale.
218 square miles surveyed on the 4-inch scale.
7 towns and cities, of an aggregate area of 51 square miles, were surveyed in detail on various scales—6, 12, 16 and 80 inches to the mile—*pari passu* with the topography.

9. Three parties had been employed during the preceding year on the Village or Mouzawar Surveys on the 4-inch scale; of these, the Budaon party has completed the survey of that district and has commenced the Cadastral Survey of District Ghazipur; the survey of the Sirsa District has also been completed, and a section of the party employed there has been engaged on the preliminary traversing for a proposed survey of the Jhelum District; the third party has continued its operations as during the previous year, partly in the Bannu and Dehra Ismail Khan Districts, and partly in the Rawulpindi District.

The Banda party, which has been principally employed in Cadastral work, has also been engaged on the 4-inch survey of a small area for the purposes of the Forest Department.

The total areas accomplished, on the 4-inch scale, by these parties are—

4,508 square miles surveyed in detail.
906 square miles of preliminary traversing.

10. The Cadastral Surveys of Districts Banda and Jaunpur, of the Khordah Estate of the Cuttack Irrigation Tracts, and of the Barkagarh Estate, have been continued as during the previous season; and of these several operations, the surveys of the Irrigation Tracts and of the Barkagarh Estate have been completed. In the case of the survey of the Khordah Estate, a modification of survey and settlement procedure has been determined on, for the reasons pointed out in paragraphs 17 to 24 of the Annual Report for 1877-78: thus no further cadastral work will be done there by this department after the termination of the field season of 1879-80. Cadastral surveys have been commenced in Districts Ghazipur, Mirzapur and Cachar, and also in the Hanthawaddy (late Rangoon) District of British Burma.

The areas surveyed by the Cadastral parties are as follows:—

533 square miles on the scale of 32-inches = 1 mile.
1,140 square miles on the scale of 16-inches = 1 mile.

11. The military operations in Afghanistan have afforded opportunities for the acquisition of additional information regarding the geography of that country, which have been made the most of. A large amount of military route

surveying on the 1-inch scale, and of geographical reconnoissance on smaller scales, had been completed up to the time of the declaration of peace and the signature of the Treaty of Gandamak. The operations embrace much ground now surveyed for the first time, as well as some ground which had been gone over by our troops and partially surveyed during the first occupation of Afghanistan.

Of new survey we have the broad belt of country beyond the northern frontier of Upper Sind, which includes Pishin and extends westwards to Shorá-wak and the edge of the great desert, and eastwards to the frontier of Dera Ghazi Khan, embracing the Khwaja Amran Range, portions of the Kakar country and the Kadanai Valley, the Toba plateau, and the congeries of valleys on the Tal-Chatiali route to India; also the country of Khost, the upper affluents of the Kuram river, the valleys on the northern slopes of the Sufed Koh range from Jamrud to Gandamak, and on the southern slopes of the same range from Kuram to the Shutargardan Pass, together with a not inconsiderable area in the basin of the Kabul river. The principal extensions of the old surveys were effected on the several routes between Quetta and Kandahar, between Kandahar and Girishk and Kalat-i-Ghilzai, and in some of the neighbouring valleys, *viz.*, the Kakhrez, the Arghandab and the Arghestan. The survey operations have covered an area of about 5,500 square miles in Northern and 15,000 in Southern Afghanistan—the smaller area being, however, much the more closely surveyed of the two.

PART I.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE DEPARTMENT.

TRIANGULATION.

I.—THE MADRAS COAST SERIES.

Personnel.

Lieutenant-Colonel B. R. Branfill, Deputy Superintendent, 2nd grade.
Mr. G. Belcham, Surveyor, 4th grade.
Mr. C. D. Potter, Assistant Surveyor, 1st grade.
Mr. A. H. Bryson, Surveyor, 3rd grade.

12. The primary object of this chain of triangles was the completion of the principal triangulation in Southern India by a regular series between Madras and Cape Comorin, with a branch series from Rámnád *viâ* Rameswaram and the adjacent islands of Palks' Straits, for the connection of the Ceylon Survey with that of India. Triangulation had been commenced in the southern portions of the Peninsula, by Colonel Lambton, at the beginning of the present century, and it had been carried down the coast from Madras to Negapatam; but it simply consisted of a narrow chain, following the coast line and avoiding the interior, which is flat and covered with trees, and was found to be altogether too difficult to be touched during those early days of the Trigonometrical Survey, when as yet no method of taking the operations through tracts of forest had been devised; thus a great blank in the triangulation has waited for the better part of a century to be filled in, and this work, which was commenced a few years ago near Cape Comorin, has now been nearly completed.

13. The season's operations were commenced at the Coleroon river, a few miles to the north of Kumbakonam, in Tanjore; passing through the north-east corner of the Trichinopoly District, the principal series traversed the South Arcot District, running parallel to the coastline at a distance of 15 to 35 miles inland through a country hitherto devoid of trigonometrically fixed points. The direct distance spanned by the principal series is 77 miles; the area covered by the triangulation, both principal and secondary, is 1,887 square miles; 17 principal stations and 40 secondary points have been fixed, giving an average of one point in an area of 33 square miles. An area of about 1,900 square miles was reconnoitred in advance for the triangulation remaining to complete the series next season.

14. The country actually operated over lay in the alluvial flats of the Coleroon, Vellar and South Pennár Rivers, and the upland flats or plateaux

between them. One of these plateaux presented an undulatory surface covered with low bush and devoid of any prominent elevations: thus it was very troublesome, necessitating long and careful examination to discover a system of mutually visible points suited for stations of the great triangulation. Happily all the difficult ground has now been passed, and the plain of the Carnatic has been reached, which is studded with hillocks and mounts of rock that are eminently favourable for the triangulation, and should enable it to be readily completed in one more field season.

15. Colonel Branfill has succeeded in finding a few of Colonel Lambton's stations and connecting them with his own operations. This will be very serviceable towards effecting a general combination of the old and the new operations, which must be done in the course of general reduction of the triangulation in Southern India. Unfortunately, some of the old stations were either not sufficiently substantially built originally, or have been wilfully destroyed, for they are now not forthcoming.

16. The out-turn of work, as measured by the usual test of distance spanned and area covered, is more than has been accomplished by this party in any previous season, since it left the Ghâts in the Tinnevelly District. Colonel Branfill is to be congratulated on having a good out-turn to show at the end of a hard season's work, which does not always happen, for, however skilfully and zealously the work may have been carried on, the progress in exceptionally difficult country is liable to be very slow, as was exemplified in the operations of this series during the previous field season. The timing of the present work happens to have been most opportune, as a Revenue Survey has recently been commenced in South Arcot, and its operations may be based on the points which have now been fixed.

17. Colonel Branfill has submitted an interesting notice of some of the places which he had an opportunity of visiting in the course of the season's work. One of these is the great Siva temple of Gangaikondapuram, situated in the north-east corner of the Trichinopoly District, which is probably the best and largest specimen of its kind, if not the oldest also; and it does not appear to have been measured and described before. The notice of this temple and various other objects of interest has been made over to and accepted by the Asiatic Society of Bengal, for publication.*

II.—THE EASTERN FRONTIER SERIES.

18. This chain of triangulation, after having been carried in previous years along the frontier line between British and Foreign Burma, and into the Peninsula below Moulmein, had reached a line about 35 miles to the south of the parallel of Tavoy, opposite a point on the British and Siamese frontier, from which the direct distance to Bangkok, the capital of Siam, is less than 90 miles. As the distance from Tavoy round the coasts of the Peninsula is fully 2,000 miles, it was very desirable, in the interests of exact geography, that a chain of triangles should be carried across the Siamese Peninsula, in order to connect Bangkok with India directly, and thus serve as a check on the maritime surveys by which the present very circuitous connection is made. The Government of Siam cordially assented to the measure when it was proposed to them through Mr. Knox, Her Brittanic Majesty's Agent and Consul General for Siam, and they promised to render all the assistance in their power towards the accomplishment of the operations.

Personnel.

Captain J. Hill, R.E., Assistant Superintendent, 1st grade.
Mr. H. Beverley, Surveyor, 1st grade.
Mr. J. F. McCarthy, Assistant Surveyor, 3rd grade.

19. The whole strength of the Eastern Frontier party was thrown on the triangulation to Bangkok, and the operations on the principal series were suspended for a season, as this could be done without inconvenience or detriment to other surveys. It was hoped that the work might be completed in a single season, provided that the country was found to be fairly favourable. But the undertaking proved more arduous than had been anticipated. Singularly enough, the belt of British territory, which had to be crossed before reaching

* Colonel Branfill reports of his Assistants, that Mr. Belcham was industrious as usual and made good progress until struck down by a bad attack of fever which compelled him to leave the field in the middle of the season. Also that Mr. Potter did good service in the selection of stations, and subsequently in the construction of the stations and scaffolding and clearing the lines, conjointly with Mr. Bryson.

the frontier, was found to be the most difficult of all to traverse; for, though a breadth of only 42 miles intervened between the frontier and the east flank of the triangulation already completed, it lay in a maze of intricate hills, which include portions of the Bean and the Tenasserim Valleys, is covered with dense forest and tropical vegetation, and is almost wholly devoid of villages and inhabitants. The hills are generally flat and have no commanding points to serve as stations of observation; their summits, which in every instance had to be cleared of trees in order to secure mutual visibility, were invisible from the valleys below, so that the process of finding a point which had been previously marked as a suitable position for a station was most difficult; to reach it in a direct line was impossible; thus it had to be approached by zig-zags through the water-courses and up the hill slopes, and with the frequent necessity of cutting openings through the dense mass of creepers and undergrowth with which the forests were pervaded, in order to clear a track for the surveyors.

20. These difficulties were greatly increased by the circumstance that the rainy season of 1878 was of unusual duration, preventing the surveyors from taking the field at the usual time, and greatly impeding their movements when, without waiting for its termination, they started on their labours; unfortunately, also, in the following year the early rains commenced much earlier than usual, and with such force as to put a stop to the operations. Thus the duration of the field season was considerably lessened by unfavourable weather, both at its commencement and ending.

21. On crossing the frontier into Siam, the country was fortunately found to be much more favourable than the British territory which had just been quitted; in a distance of 65 miles the facilities were so much greater that not only were the stations of observation selected, but the whole of the observations were taken; whereas, in a distance of 42 miles on the British side, several of the angles remained unobserved. In Siam the triangulation was completed up to a point within 25 miles of Bangkok. The country remaining to be crossed is an alluvial plain in the valley of the Mainam River, which is studded with towns and villages and covered with trees, and would ordinarily be very troublesome to get over; but Captain Hill has ascertained that the existing pagodas, supplemented by two or three high platforms, which will have to be specially erected, will suffice as stations for the connecting triangulation. He has been promised all necessary assistance, in the loan of spars and planks of timber, for the erection of these structures.

22. The Siamese officials have done much to facilitate the progress of the operations. Bringing an interpreter with them, they met Captain Hill at Tavoy and accompanied him throughout his travels; it happened, unfortunately, that at the Amoy Pass, on the border line, four of their men died of fever, the locality being very unhealthy: this created some alarm at the time, which, however, passed off quickly, and all necessary assistance was cordially rendered throughout the field season. After the termination of the operations, a letter was received from Mr. Knox, the British Consul at Bangkok, for communication to the Government of India, reporting that Captain Hill, by the judicious manner in which he had carried on his duties, had succeeded in securing the good will of all the Siamese with whom he had come in contact, and further promising that every assistance should be rendered to him on his return during the following field season.

23. The programme of the operations of this party for next season is for Captain Hill and Mr. McCarthy to complete the branch series of triangulation to Bangkok; meanwhile Mr. Henry Beverley will extend the principal series to the southern extremity of Tenasserim, which, being also the southern extremity of the British territories in the Peninsula, will be a suitable point for bringing the principal triangulation to a termination. Arrangements are therefore being made for the selection of an appropriate site for a base-line of verification near the end of the series, to be measured in 1880-81 with the Colby apparatus of compensation bars and microscopes, with which all the great base-lines of this Survey have been measured since the year 1830.*

* Captain Hill considers Mr. Henry Beverley to have done a good season's work, though, from causes beyond his control, he was unable to complete the task which had been allotted to him. Mr. McCarthy is very favourably reported of, both for the energy and skill with which he carried on his operations, and for tact in his dealings with the natives of Siam.

III.—THE SECONDARY TRIANGULATION IN UPPER SIND AND BILUCHISTAN.

24. This triangulation is based on a side of the Great Indus Series, near Jacobabad, and was commenced during the preceding field season by Captain Rogers, with a view to affording a basis for the geography of Biluchistan. When war was declared with the Amir of Afghanistan, Captain Rogers was attached to the army in Southern Afghanistan, with a view to being employed in making any surveys which opportunities might permit of his undertaking. His senior Assistant, Mr. Price, was put in charge of the party, and sent to complete the triangulation.

Personnel.
Mr. W. C. Price, Surveyor, 4th grade.
„ C. P. Torrens, Assistant Surveyor, 2nd grade.

25. It had been commenced at both ends, but very little had been done in the plains between Jacobabad and the Bolan Pass. This region is known, only too well, as being for the most part a flat and woodless waste of inhospitable desert, with little water and very few villages, the climate varying between great extremes of heat and cold. There are no natural elevations for stations of observation; and the frequent mirage and haze render all objects at a little distance very indistinct, and make it most difficult to take observations during the greater portion of the day, either to luminous signals, as heliotropes, or to opaque signals and marks, and to ordinary objects. Occasionally towers were met with in the villages, and, as these could be converted into stations, they were employed whenever available. At other places the theodolite was set up on a massive wooden frame-work, in order to extend the range of view and increase the height above ground of the rays of light coming from the signals or other objects under observation. With a view to completing the regular number of measures of each angle of the chain, without delaying a long time for the purpose, much of the observing was done by night, to lights, which were specially improvised by Mr. Price when he found that the atmosphere was usually much more favourable for observing by night than by day. The hills were struck near the entrance to the Bolan Pass, after which the triangulation was carried on without further difficulty from atmospheric causes, though occasionally at some risk from the lawless marauders by whom the country is infested.

26. The triangulation was carried by Mr. Price up to Quetta and extended by Mr. Torrens to the boundary of Peshin, beyond Quetta; it spans a direct distance of 153 miles, and is a creditable performance considering all the difficulties under which it was executed. A connection was made with the stations of a preliminary triangulation, emanating from a provisional base-line measured at Quetta, which has been extended to Kandahar, in sections executed at different times, by either of the survey officers with the army in Afghanistan, who could manage to find suitable opportunities for ascending and taking observations from the hills near the lines of route. That work has necessarily been executed hurriedly and under many disadvantages; but as it rests on an exact triangulation, it is of much value for the rectification of the existing maps of the country between Quetta and Kandahar.*

IV.—THE SECONDARY TRIANGULATION IN BURMA.

27. The work remaining to be completed was,—1st, the continuation of the triangulation to Cape Negrais and Alguada Light-house, in the Bassein District; this was taken in hand by Mr. W. Beverley, who had returned from furlough and relieved his brother, Mr. H. Beverley, of the charge of the party; 2ndly, the extension of the triangulation along the coast in the Rangoon District towards the proposed sites of the two beacons which are to be constructed on the mainland opposite the Krishna Shoal, the site of the Krishna Light-house, which mysteriously disappeared in 1878; this work was commenced by Mr. Hughes, early in December.

Personnel.
Mr. W. G. Beverley, Officiating Assistant Superintendent, 2nd grade.
Mr. J. O. Hughes, Assistant Surveyor, 2nd grade.

* Mr Torrens was employed during the principal portion of the field season in carrying a chain of secondary triangles from the Eastern Sind Series to Jesalmir, and in laying out another chain to connect Sehwan with the series. He was then sent to join Mr. Price in the operations in Biluchistan. He has submitted some interesting notes on portions of the Jesalmir and Khairpur States, which are given in the Appendix.

28. Mr. W. Beverley carried the triangulation in the Bassein District a direct distance of 28 miles by stations on either bank of the Bassein River, and terminated it on the promontories of Mau-deng and Chaukálá running into the Bay of Bengal. From these two stations and one on the hill on the Island of Hainji or Negrais, at the mouth of the river, the positions of the Alguada Light-house and also of points on Diamond Island were determined. Mr. Beverley states that the ground traversed by the triangulation is about the most trying and difficult that he had ever met with. On the right flank the stations are on hills, which were flat-topped and of almost uniform height; thus rays had to be cleared for some distances over densely-wooded spurs to obtain mutual visibility of stations. On the left flank the triangulation was carried over low ground intersected by numberless creeks and streams, which, getting submerged at each flood tide, much time was lost in opening out the lines. There are also few villages along the banks of the Bassein River, and, as the country gets inundated to some distance, there are no available sites for encamping on. Most of the travelling had to be done by boat, sometimes over broad and dangerous streams and at others over narrow creeks flowing through forest, and accessible only during flood-tide.

29. The extension of the Rangoon triangulation along the coast towards the Krishna Shoal was carried a direct distance of 20 miles by Mr. Hughes. Some time was spent in re-clearing old rays, cut during the previous season, but found choked up, and in collecting materials for constructing post stations. Altogether, with the re-clearing of old and cutting of new lines, 97 miles of rays had to be cleared, in most parts through heavy forest and swampy tracts covered with thick jungle. Mr. Hughes suffered from repeated attacks of fever, which greatly interfered with his progress.

30. There still remains a good extent of triangulation before the position of the beacons can be determined finally. As the country is an immense jungle, and rays would have to be cut between all the stations, and the population is so scanty that labourers are not to be met with on the spot, but must be imported from a distance, and as Mr. Beverley anticipates that the work would take two years more to complete, the fixing of the beacons by any further extension of the triangulation has been abandoned: arrangements have been made to carry a traverse to them from the nearest trigonometrical station, which, by avoiding the forest tracts and keeping to open ground, may probably be completed in six or eight weeks. This traverse will be executed with the aid of the Survey Party under Captain Sandeman, which is engaged on the Cadastral Survey of the Rangoon District, and it will be done in such a manner as best to subserve the future requirements of that Survey and form a part of the general system of traverses which will be required. Though not quite so accurate as a triangulation, it should be sufficiently accurate for the purpose of fixing the positions of the beacons on the Krishna Shoal for the Marine Survey.

TOPOGRAPHY.

V.—GWALIOR AND CENTRAL INDIA SURVEY (No. 1 TOPOGRAPHICAL PARTY).

31. In accordance with the orders of Government, conveyed in letter No. 434, dated 22nd October 1878, this party was partly diverted from its usual work to take up the following special surveys in the Native State of Jodhpore, required by the Inland Customs Department:—

1st.—A survey of the Pachpadra salt fields, scale 4 inches—1 mile.

Personnel.

Captain C. Strahan, R.E., Deputy Superintendent, 3rd grade, in charge during the field season.
Major T. T. Carter, R.E., Deputy Superintendent, 2nd grade, in charge during the recess season.
Mr. H. J. Bolst, Surveyor, 1st grade (died 7th July 1879).
" T. E. M. Claudius, Assistant Surveyor, 1st grade.
" W. J. Cornelius, " 1st "
" P. J. W. Dorsan, " 2nd "
" C. T. Templeton, " 3rd "
" G. P. Tate, " 4th "
L. R. Harris, Sub-Surveyor.
Ajal Goffar, "
Girdhári Lall, " and four others.

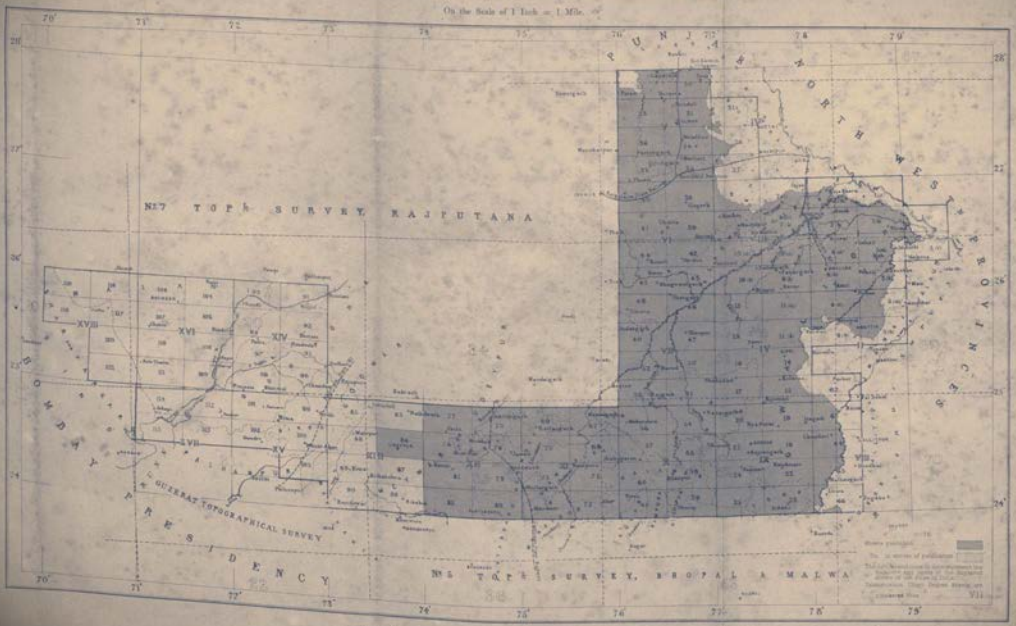
2nd.—A survey of the tract intervening between the salt pits and the Luni River, taking in the town of Tilwára, scale 1 inch=1 mile.

3rd.—A survey of the course of the Luni River, from Tilwára to the Runn of Cutch, shewing a breadth of half a mile on each side, till the "Nayar" land should be met, when the country surveyed on either side was to include all this land.

No. 1 PARTY

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

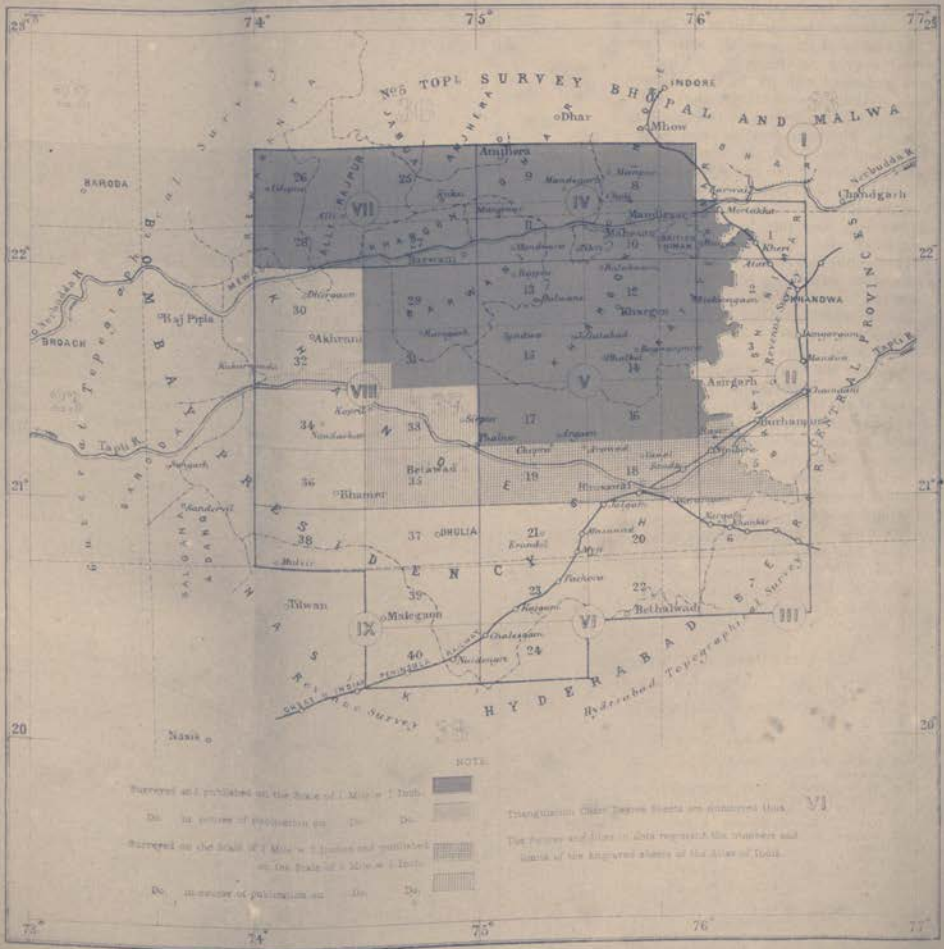
On the Scale of 1 Inch = 1 Mile.



No. 2 PARTY

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY.

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1902.

The details required were communicated to Captain C. Strahan by the Officiating Commissioner of Inland Customs, in person.

32. The ordinary work of the party consisted of a detail survey of the City of Oodeypúr and environs on the scale of 12 inches=1 mile, the detail survey on the scale of 1 inch=1 mile of as much of the ground in the neighbourhood of the above operations as should be possible, and of preparation by triangulation of ground for future survey on the standard scale.

33. The operations of this party were consequently scattered over a considerable area between the parallels of 24° 15′ and 26° North latitude, and between the meridians of 71° 15′ and 73° 45′ East longitude. The final results of the season's work are represented by 2298·3 square miles of detail survey on the scale of 1 inch=1 mile; 32·3 square miles on the scale of 4 inches=1 mile of the Pachpadra salt-pits survey; 10·78 square miles on the scale of 12 inches=1 mile of the City of Oodeypúr and environs; and by triangulation extending over 1,668 square miles required for the Luni River survey.

34. The triangulation was carried out by Captain C. Strahan, Mr. H. J. Bolst, and Mr. T. E. M. Claudius; the detail survey, by Mr. Claudius and the other members of the party, supervised, examined, and tested by Mr. Bolst.

35. The Pachpadra salt-pit tract is shewn on two sheets on the large scale, also on the scale of 1 inch=1 mile in standard sheet No. 93; and the Luni River, from the pits to the Runn of Cutch, in three sheets, on the scale of 1 inch=1 mile. On the larger scale, each salt-pit is defined and is marked by a reference number; on the latter maps, the limits of the "Nayar" or hard land cultivation extending to a distance of from 1 to 1½ miles on either side of the Luni and its branches, are shewn by dotted lines. This soil, which possesses valuable wheat-growing properties, is formed from alluvial deposits carried down when the river is flooded. To avoid confusion, no other cultivation has been defined. The fair mapping of standard sheets 83 and 87 has been completed, and the city and environs of Oodeypúr have been shown on five sheets.

36. The Department at large, and this party in particular, have been deprived of the services of one of its highly-valued members. Mr. H. J. Bolst, on his return to recess quarters, was attacked by typhoid fever, to which, after a long illness, he succumbed on the 7th July. He had been 27 years in the Department, of which the last 17 had been spent in this party, and from his strict attention to the various duties in which he had been engaged, and the willing manner in which he carried out all that was entrusted to him, combined with his excellent personal character, he had deservedly gained the esteem of all the officers under whom he had served, and of his brother Surveyors with whom he had been so long associated.

37. During the current year, this party will be engaged on the detail survey, on the 1-inch scale, of standard sheets Nos. 86, 88, 90 and 94, and on the completion of about 270 square miles of triangulation in degree sheet XIII.*

VI.—KHANDESH AND BOMBAY NATIVE STATES SURVEY (No. 2 TOPOGRAPHICAL PARTY).

38. The operations of this party are purely topographical, and were carried on in the Khandesh District and neighbouring petty native states of Chota Udepur, Garh, Mathwar, &c. They may be divided into three distinct classes, *viz.*, triangulation, detail survey on the scale of 1 inch =1 mile, and detail survey on the scale of 2 inches = 1 mile.

Personnel.

Mr. H. Horst, Assistant Superintendent, 1st grade, in charge during the field season.
Captain G. Strahan, R.E., Deputy Superintendent, 2nd grade, in charge during the recess season.
Mr. A. G. Wyatt, Surveyor, 4th grade.
„ G. Barker, Assistant Surveyor, 1st grade.
„ W. Pettigrew, „ „ 2nd „
„ A. Cooper, „ „ 2nd „
„ F. Warde, „ „ 3rd „
„ G. VanderBeck, „ „ 3rd „
„ E. Graham, „ „ 4th „
„ C. George, „ „ 4th „
Shaik Omer, Sub-Surveyor.
F. Rosario, „ and four others.

39. Of the first class, an area of 643 square miles in the south-east corner of the Khandesh District, embracing portions of the talukas of Bhusawal and Jamner,

* Major Carter commends favourably the work of Messrs. Claudius and Cornelius, the large-scale work of Mr. Doran in the city of Oodeypúr, the drawing of the Luni River maps by Mr. Templeton, and the hill drawing on the large scale plan of Oodeypúr by Mr. Tate.

was completed. This tract falls into the portions marked in the index map as standard sheets 6, 7, 20, and 22, south-east of Bhusawal.

40. Of the second class, an area of 642 square miles was surveyed, lying for the most part on the Satpura hills, between the Nerbudda and the Tapti rivers. This ground presents great obstacles to Surveyors, partly from the height and rugged character of the hills, but chiefly from the difficulty in getting supplies, and the generally inhospitable nature of the country. The only water available for drinking purposes seems to have been of the most unwholesome description, to which cause may be attributed the constant attacks of fever to which the assistants who surveyed the worst portions were subjected. The culminating point of the range "Astamba," 4,346 feet above the sea-level comes into the season's work.

41. Of the third class, or detail survey on scale 2 inches = 1 mile, a tract extending over 893 square miles was surveyed, situated chiefly between the town of Dhulia and the Tapti River. This ground, commonly known as the revenue-paying portion of the district, is of a very different character to that above described, and consists of extensive undulating plains, becoming, however, somewhat hilly and stony towards the south, and which hitherto has not been found so difficult as to render the progress of the survey abnormally slow. An attempt has been made (and to a great extent successfully) to incorporate previous revenue survey work with these operations. This remark applies especially to the case of the village boundaries, all of which have hitherto been entered on the topographical maps from the existing revenue survey village plans To admit of this being done, it is necessary that the trijunction boundary-marks of villages should be laid down with considerable accuracy, for which purpose some numerical record of their positions must be kept for future reference, by which their sites can at any time be identified with far greater accuracy than would be possible by mere measurements from a map, however skilfully prepared. The numerical record necessitates a system of traversing which occupies a large portion of the time of the party. During this field season, 615 linear miles of these traverses were run.

42. By these combined operations four standard sheets, Nos. 30, 32, 33 and 35, have become available for publication.

43. During the current field season the detail survey on the 2-inch scale will be extended over the ground to the west and north-west of Dhulia as shewn on the Index map by sheets 34, 36, 37, 38. The country lying in the southern portion of the Khandesh District, embracing an area of about 2,200 square miles, will be triangulated.*

VII.—BHOPAL AND MALWA SURVEY (No. 5 TOPOGRAPHICAL PARTY).

Personnel.

Major J. R. Wilmer, S.C., Officiating Assistant Superintendent, 1st grade, in charge.
Mr. D. Atkinson, Surveyor, 2nd grade.
" C. F. Hamer, " 4th "
" E. A. Wainwright, Assistant Surveyor, 1st grade.
" H. T. Kitchen, " 2nd "
" W. H. Lilley, " 2nd "
" A. Kitchen, " 3rd "
" G. R. Copping, " 4th "

Prem Raj, Sub-Surveyor.
Hatkill Sing, " and three others.

44. The operations of this party were confined to the country between the parallels of North latitude 22 and 23° 30′, and between the meridians of East longitude 74° 30 and 75 30′, embracing portions of the independent native states of Gwalior, Indore, Jhabua, Dhar, Sailana, and Rutlam.

45. The triangulation was carried over 1,720 square miles of country, chiefly of an easy nature, falling in the locality marked by sheets 53, 55, 56, 57; and the detail survey, amounting to 2,252 square miles on the scale of 1 inch to the mile, covered the ground shewn on the index map by sheets 42, 44, 46, 48. About a quarter of this area was in hilly ground covered with jungle, the rest in open, well-cultivated land.

46. In addition to the above, large-scale surveys were made of the City of

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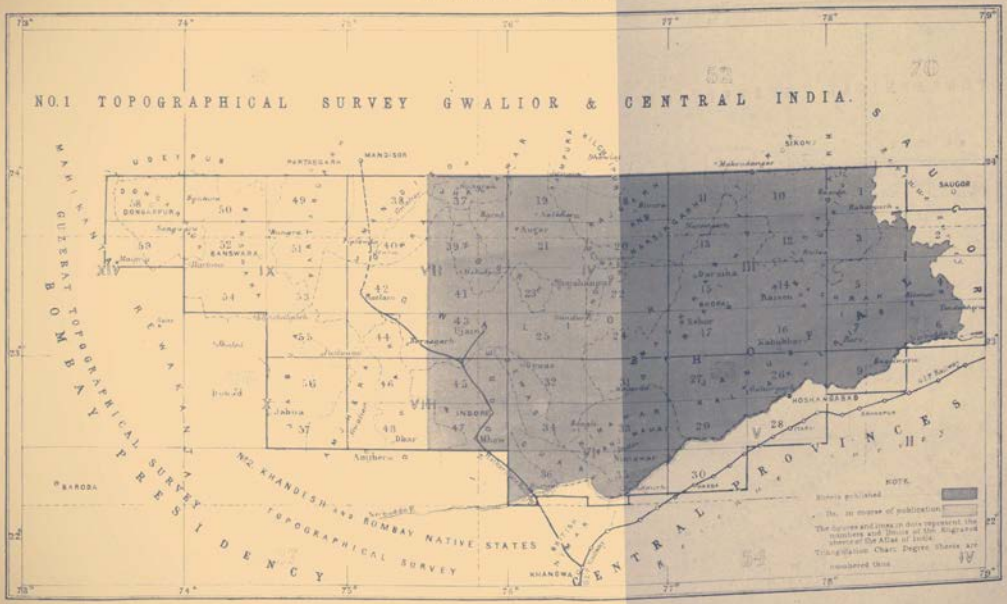
* Mr. Horst reports favourably of the work done by Messrs. Wyatt, Barker, Wards and G[illegible]. He specially commends the work of Sub-Surveyor Sheikh Omar, and mentions favourably Sub-Surveyors Rosari, Vishnu Moteshwar, and Bapu Jadu.

No. 5 PARTY

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



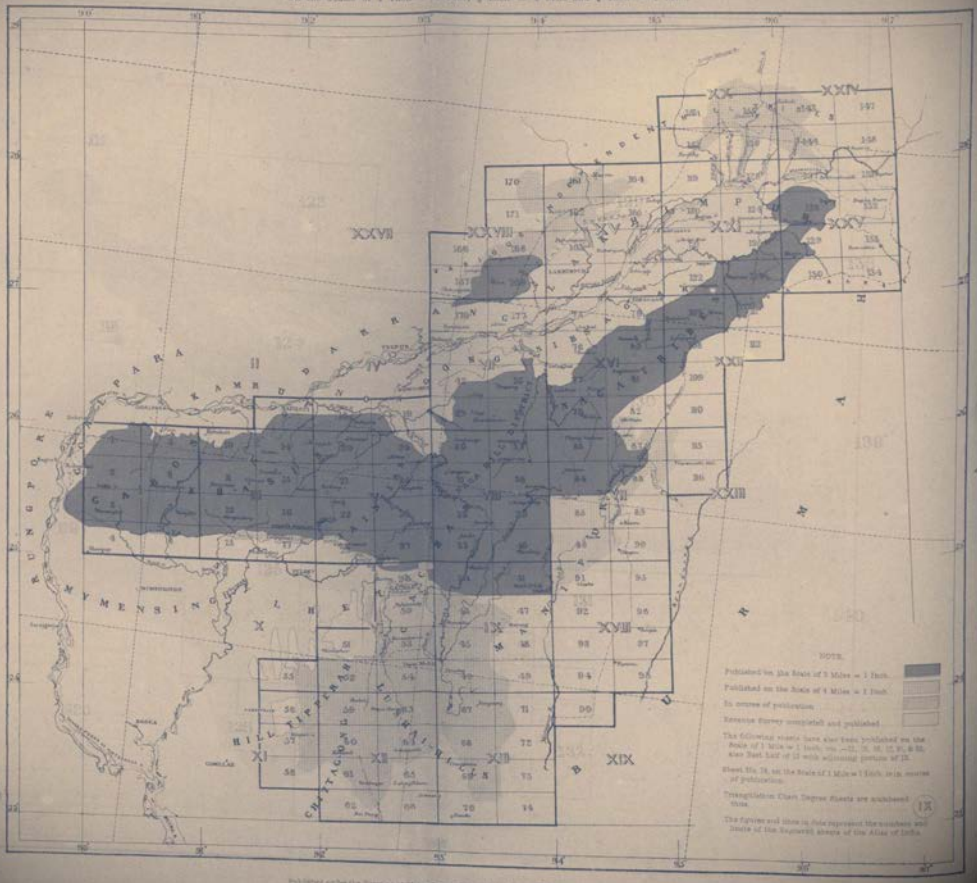
Published by the Authority of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

at the Survey of Indian Office, Calcutta, October 1883.

No. 6 PARTY

INDEX TO THE SHEETS OF THE GARO, KHASI AND NAGA HILLS TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile and ¼ Inch = 1 Mile.



Published under the Direction of Major-General C. S. Walker, R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, December 1875.

Indore and environs on the scale of 12 inches to the mile, and of Dewas on the scale of 6 inches to the mile; and triangulation was prepared in advance for the large-scale surveys of the City of Dhar and of the cantonments of Sirdarpore.

47. The results of the work of this party during the year under report will enable standard sheets 24, 44, 46 and 48 to be published, as well as the plan of the City of Dewas in one sheet.

48. During the current season the triangulation will be carried over the ground falling between $\frac{\text{Lat.}}{\text{Long.}}$ $\frac{23°-24°}{74°-75°}$. The detail survey on the 1-inch scale will be extended over the tract shewn on the index map by standard sheets 55, 56 and 57, and large-scale surveys on the scale of 6 inches to the mile will be made of the City of Dhar and of the cantonments of Sirdarpore.

VIII.—KHASIA AND GARO HILLS SURVEY (NO. 6 TOPOGRAPHICAL PARTY).

49. This party has been employed for several years in surveying the hill tracts to the south of the Brahmaputra River. Different portions have been done on different scales, depending on their value to Government and general accessibility. The greater portion has been done on the scale of $\frac{1}{2}$ an inch to the mile, the more valuable portions between Gauhati and Sylhet on that of 1 inch to the mile, and various out-lying tracts, occupied by independent hill tribes, on that of $\frac{1}{4}$ of an inch to the mile. In 1877, the late Chief Commissioner, Colonel Keatinge, intimated to the late Surveyor-General, General Thuillier,* that a necessity had arisen for a survey of the southern portions of Sylhet and Cachar, which he considered of much greater importance than any other surveys that were under contemplation for his province, because the want of it was supposed to be costing Government heavily in fraudulent zamindari claims. This survey, he said, should be either revenue or topographical, and evidently on a larger scale than the survey which was then actually in progress.

Personnel.

Major W. F. Badgley, S.C., Officiating Deputy Superintendent, 3rd grade, in charge
Mr. F. Grant, Surveyor, 2nd grade.
" M. J. Ogle, " 4th "
" A. W. Chennel, Assistant Surveyor, 1st grade.
" J. McCay, " 3rd "
" D. Campbell, " 4th "

Munshi Shah Nusirudin, Sub-Surveyor.
" Taher Mahommed, " and seven others.

* Letter No. 1804, dated 14th July 1877.

50. In his letter No. 7, dated 2nd January 1878, Colonel Keatinge stated that what was required in the first instance was a full topographical survey on the scale of 2 inches to the mile, of all the land in the south of the Sylhet District left unsurveyed by the Revenue Survey; and afterwards a detailed survey of the boundaries of tea grants and estates on the 4-inch scale, if such should be practicable. If not, the boundaries were to be shewn on the 2-inch topographical maps. Colonel Keatinge particularly requested that the primary topographical survey should be done by the party then available, obviously meaning Major Badgley's party.

51. Major Badgley was immediately instructed accordingly; and as his party was not well constituted for boundary survey work, a detachment from the Revenue Survey Branch was placed under his orders. The increase of scale was not very considerable, and Major Badgley and his assistants had already in previous years done a large amount of boundary work on the 2-inch scale, and though the annual out-turn of work of the party, as measured by area, would be materially diminished and the mileage rate correspondingly increased, it was considered that the actual cost to Government, which is the main thing to be thought of, would probably be very much less by having the work done by the party which was in the neighbourhood, and was provided with a trigonometrical basis of operation, than by some other party sent from a distance, and having to commence operations *de novo*.

52. During the season under report, the triangulation on which the detail survey operations are based was carried on under great difficulties, the stations of observation being in most cases the stumps of trees of which the tops had been cut off. In some cases the instruments had to be set up on stumps 40 feet

high, and the observers had to work on platforms supported by bamboo scaffoldings constructed round these stems in such a manner that neither scaffold nor supports touched the trunks of the trees. The points fixed were almost always large bamboo baskets fastened on the tops of high trees. In this manner the triangulation was extended over an area of 900 square miles.

53. The detail survey, covering an area of 218 square miles on the scale of 1 inch=1 mile and 82 square miles on the scale of 2 inches=1 mile, was carried on in country very similar to that over which the triangulation was extended. Major Badgley writes as follows in connection with the descriptions of the country:—

"If a man with a chopper was put down in some parts of it, half a mile from where he could get food, he would not cut his way out before he was starved."

The detail survey on the 2-inch scale of an area of 63 square miles involved the building of 247 platforms in trees and the traversing with a chain of 357 linear miles.

54. By the operations of the year under report, the maps of the hitherto unsurveyed portions lying at the foot of the Khasia and Jynteah Hills can be completed, and sundry small blanks in other maps can be filled up.

55. This slow rate of progress led the officer in charge (who, as well as the late Surveyor-General, had always been opposed to the larger-scale work being undertaken by his party) to bring the subject up for re-consideration; and as the present Surveyor-General had no objection to his reverting to a more rapid style of work, provided that the present Chief Commissioner should be of opinion that what was being done was not really wanted, instructions were given to Major Badgley to prepare a skeleton map of the country on the scale of $\frac{1}{4}$ of an inch to the mile, and to mark off on the map the several areas to be surveyed on different scales, in accordance with his own views on the subject. This map was submitted to the Chief Commissioner for approval or modification.

56. After careful consideration, and with the approval of the Chief Commissioner,* it was decided that six detached unsurveyed portions of the Sylhet District, aggregating an area of about 560 square miles, should be surveyed on the scale of 2 inches to the mile; an area of about 210 square miles, in the Langai valley and neighbourhood, should be surveyed on a scale of $\frac{1}{2}$ an inch to the mile; and that two tracts lying in Hill Tipperah, aggregating an area of about 340 square miles, should be surveyed on the scale of $\frac{1}{4}$ of an inch to the mile.

* Letter No. 1754, dated 23rd September 1879, from the Secretary to the Chief Commissioner, to the Surveyor-General.

57. In accordance with this decision, Major Badgley will endeavour to complete the survey of the $\frac{1}{2}$-inch work, and of as much of the 2-inch work as possible, during the current field season.*

IX.—THE RAJPUTANA SURVEY (No. 7 TOPOGRAPHICAL PARTY).

58. This party assembled at Delhi on the 15th October, and, as stated in paragraph 92 of the Report for the year 1877-78, started with the intention of extending the triangulation over Degree sheets XIV, XV, and XVI, and of completing the detail survey of the northern portion of Degree sheet XII and of the whole of Degree sheet XIII.

Personnel.

Lieut.-Colonel G. C. Depree, S.C., Deputy Superintendent, 1st grade, in charge.
Mr. J. McGill, Surveyor, 2nd grade.
" E. S. P. Atkinson, " 4th "
" J. A. Vanderputt, " 4th "
" J. H. Wilson, Assistant " 2nd "
" W. C. G. Barckley, " " 3rd "
Modhusudun Dutt, Sub-Surveyor.
Eusuf Sharif, "
Imam Sharif, " and four others.

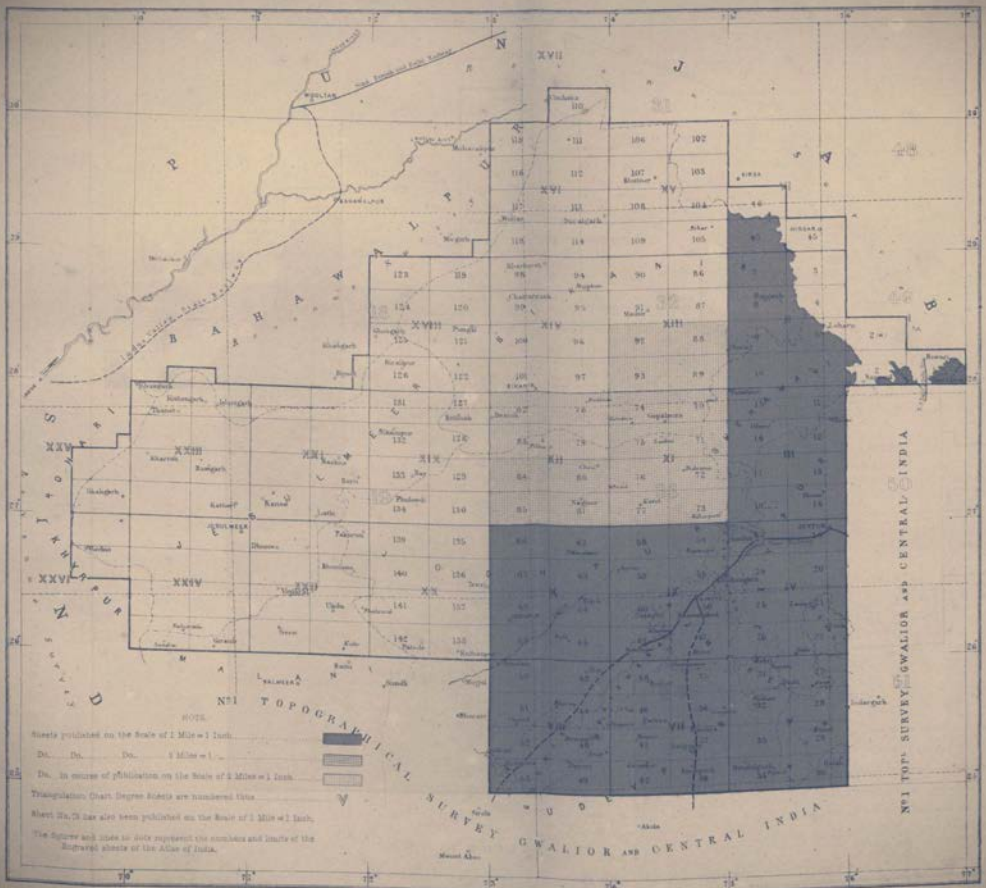
59. Owing to sickness and the transfer, in the early part of the field season, of two sub-surveyors to Afghanistan, the latter part of the programme had to be modified and the triangulation had to be slightly curtailed. The results, however, were, of triangulation, an area of 9,860 square miles in which 1,198 points were fixed: and of detail survey on the scale of $\frac{1}{2}$ an inch to the mile, an area of 5,424 square miles; the former in the Bickaneer Territory, the latter in the States of Jodhpur, Bickaneer, and Shaikhawati.

* Major Badgley reports favourably on the work of his assistants, Messrs. Grant, Ogle, Chennell, McCay, and Campbell, and of Múnshi Shah Nusirúdin.

No. 7 PARTY

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile and ½ Inch = 1 Mile.



NOTE.

Sheets published on the Scale of 1 Mile = 1 Inch.

Do. Do. Do. ½ Mile = 1 ,,

Do. In course of publication on the Scale of ½ Mile = 1 Inch.

Triangulation Chart Degree Sheets are numbered thus

Sheet No. 78 has also been published on the Scale of 1 Mile = 1 Inch.

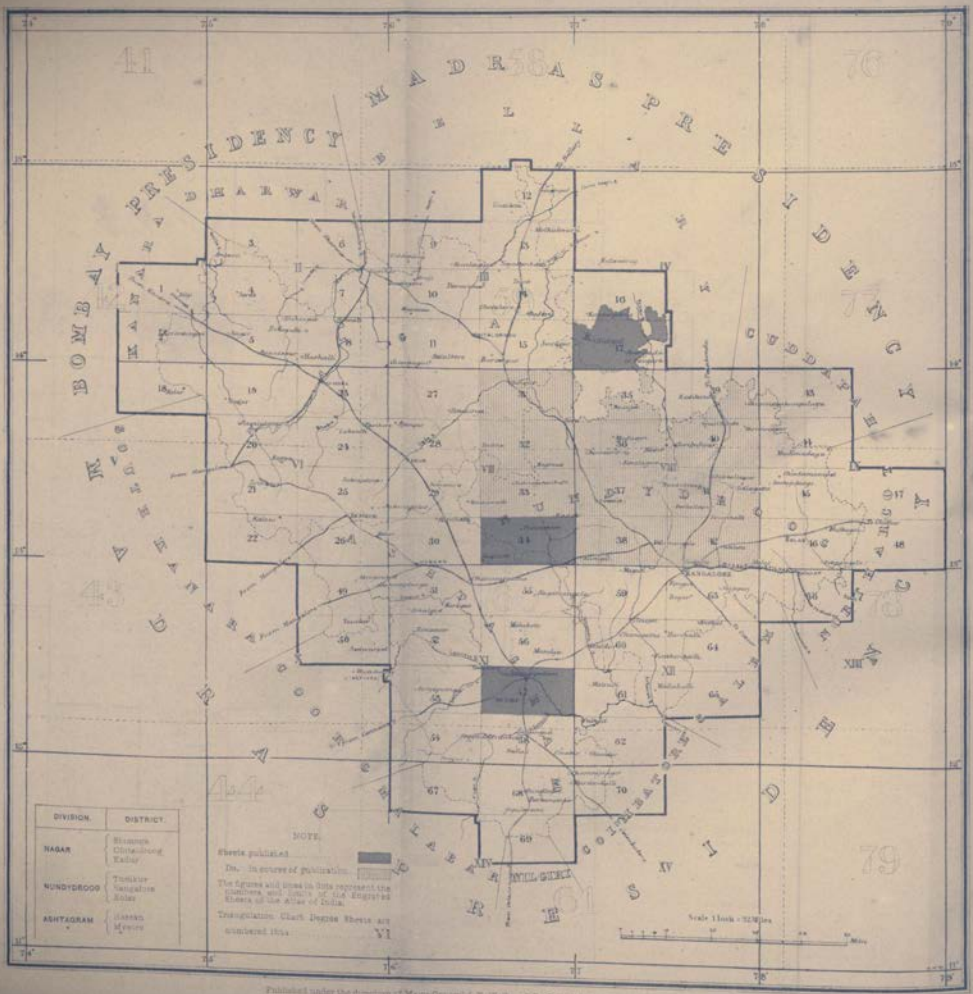
The figures and lines in dots represent the numbers and limits of the Engraved sheets of the Atlas of India.

Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1879.

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,

at the Surveyor General's Office, Calcutta, November 1870.

60. By these results, the publication of the maps of the northern half of Degree sheet XII and of the southern half of Degree sheet XIII can be made. Lieutenant-Colonel Depree states that the character of the country in which the operations of this party were carried on is uninteresting, but as the greater portion of the tract is beyond the ranges of ordinary tours, he has made some notes, which will be found in the appendix.

61. During the current season, the detail survey will be extended over the tract shown on the Index map as Degree sheet XIV, and over the unfinished portion of Degree sheet XIII; and as a very large area has been prepared for detail survey by previous triangulation, the operations of this nature will be limited to a small tract in the northern portion of Degree sheets XV and XVI.*

X.—THE MYSORE SURVEY (No. 8 TOPOGRAPHICAL PARTY).

62. This party was employed in continuing the topographical survey of the Mysore State on the scale of 1 inch to the mile. Its strength during the year under report was increased by the return of four surveyors and assistant surveyors, and three sub-surveyors from the Public Works Department of Mysore, to which they had been temporarily deputed for employment on famine relief works. The party worked in two detachments, one being employed on triangulation in the Malnád, or highland region bordering South Canara, in Degree sheets VI and X, and the second on the detail survey of sheets 31, 32, 35, 36, 39, 40, and 41, and on the large scale survey of such of the State forests which were embraced in the above area. The larger part of this area lay in the Túmkúr and Kolár Districts, with a small portion of the Chitaldroog District on the north and west, and of the Bangalore District to the south-east.

Personnel.

Major H. R. Thuillier, R. E., Deputy Superintendent, 1st grade, in charge.
Captain J. R. McCullagh, R.E., Officiating Assistant Superintendent, 1st grade, joined on 6th May 1879.
Mr. R. W. Chew, Surveyor, 2nd grade.
" H. E. T. Keelan, " 2nd "
" L. J. Pocock, " 4th "
" A. J. James, Assistant Surveyor, 1st "
" F. Kitchen, " " 1st "
" W. Stotesbury, " " 1st "
" H. Todd, " " 1st "
" W. McNair, " " 2nd "
" W. Oldham, " " 3rd "
" G. L. Fleming, " " 4th "
" J. Kennedy, " " 4th "
Mahomed Zikeria, Sub-Surveyor
Janki Dass, "
Raghavayengar, "
Poonasamy Pille, "
and six others.

63. A very large area of ground had been previously prepared for survey, so that further triangulation would not have been required for some time, had not the Local Administration required maps of the tract between Mysore and South Canara to aid in the settlement of that long debated Frontier line; this portion of the country had not been prepared for detail survey, so fresh triangulation was incumbent. The total area completed was 4,850 square miles in a wild and hilly country.

64. The out-turn of detail survey amounted to 3,367 square miles in varied ground, having a considerable amount of detail, some parts consisting of bold rugged hills, occasionally rising into high peaks, some 1,000 feet to 1,800 feet above the neighbouring plain; in others, fine open undulating country with magnificent series of tanks, was met with. This work was duly tested by 195 linear miles of check traverses in the open portions of country, and by *in situ* examinations in the hilly parts, and was found to be accurately and carefully done. In addition to the above work, surveys of the State forests of Devaraydurga and Nundydroog were executed on the 4-inch scale for the use of the Forest Department of Mysore, under the orders of the Government of India, embracing an area of 36·3 square miles for which 35 linear miles of boundary and road traverses were run.

65. The results of this season's work furnish material for the publication of standard sheets 31, 32, 35, 36, 39, 40, and 41, on the scale of 1 inch to the mile.

66. In order to meet the requirements of the Local Government, the whole party will be employed during the current season in the detail survey of the Mysore and South Canara Frontier until it may be necessary to transfer the operations to tracts offering less risk to the health of the surveyors. This boundary falls in parts of sheets 18, 19, 20, 21, 22, 26, 49, and 50, in the

* Lieutenant-Colonel Depree commends the work of Messrs. McGill, Atkinson, and Wilson, and of Sub-Surveyors Eusuf Sharif, Imam Sharif, Sher Shah, and Hossein Buksh.

districts of Hássan, Kadur, and Shimoga, and presents great difficulties to the surveyor, owing to the denseness of the forest.*

XI.—THE GUZERAT TOPOGRAPHICAL SURVEY.

67. The operations of this survey have been conducted under the supervision of Lieutenant-Colonel Haig, R.E., who returned from furlough and resumed charge of the party on the 5th October 1878.

Personnel.

Lieutenant-Colonel C. T. Haig, R.E., Deputy Superintendent, 2nd grade, in charge.
† Lieutenant St. G. C Gore, R.E., Assistant Superintendent, 2nd grade.
Mr. T. A. LeMesurier, Assistant Superintendent, Guzerat Revenue Survey.
Mr. A. D'Souza, Surveyor, 1st grade.
„ A. Christie, „ 4th „
„ C. H. McA'Fee, Surveyor 4th grade.
„ J. Bond, Assistant Surveyor, 1st „
„ G. D. Cusson, „ 2nd „
„ S. F. Norman, „ 4th „
„ C. A. Norman, „ 4th „
† „ R. F. Warwick, „ 4th „
„ A. George, „ 4th „
H. G. Ferns, Sub-Surveyor.
Gopal Vishnu, „
Lakshuman Gharparé, „
and 22 Native Sub-Surveyors and Apprentices.

68. There are three descriptions of work being carried on by this survey, *viz.*,—

(1) The ordinary topographical survey published on the scale of 1 inch to a mile, but executed on that of 2 inches to the mile.

(2) The publication of a special series of maps on the scale of 2 inches to a mile of British territory, including in addition to the details of the ordinary maps on the 1-inch scale, minor roads and communications, and so many of the field boundary triple junctions and other points on the village maps drawn up by the Guzerat Revenue Survey as would facilitate their being readily supplemented with the details of those maps by transference from one to the other whenever it might be necessary for the projection of any new road, canal, or other engineering work.

(3) The forest survey of the Dangs on the scale of 4 inches to a mile.

69. The first two of these progress *pari passu*, that is to say, as the ordinary survey progresses over the province in "sheets" or regular areas bounded by meridians and parallels of latitude; the British territory in these "sheets" is specially treated and mapped. The survey of the Dangs is an entirely distinct work, carried on as rapidly as circumstances will permit, without suspending the ordinary topographical operations. For the special series of maps of British territory on the 2-inch scale, a special auxiliary agency is furnished by the Bombay Government, consisting of an Assistant Superintendent from the Guzerat Revenue Survey and a Native establishment provided at a cost of Rs. 500 a month. The Bombay Government have also contributed towards the extra cost of the Dangs' survey as mentioned at page 28 of last year's General Report; but this is a matter of account between the Imperial and Local Governments, and does not affect the personnel of the Guzerat party.

70. The ordinary topographical work was carried on over an area of 1,203 square miles, sub-divided between British and Foreign territory as under:—

British	Ahmedabad Collectorate	235	square miles.
	Kaira ditto	73	„
Foreign	Baroda Territory	322	„
	Mahi Kanta States	450	„
	Rewa Kanta States	123	„

and is so situated as to admit of the publication of two "sheets" ($\frac{1}{2}$ a degree longitude by $\frac{1}{4}$ of a degree latitude), *viz.*, 25 and 26 indicated on accompanying Index Chart, and comprizes also the western half of sheet 5. The British territory in these two sheets, though little more than half a "sheet" in aggregated area, is so scattered as to necessitate the drawing of 8 maps, each the size of a standard "sheet," for publication on the 2-inch scale, which made the work of preparing the special series of maps, very heavy.

71. The operations of the past season bring the total area topographically surveyed in Guzerat up to 11,500 square miles, and leave about 19,500 square miles to be done hereafter.

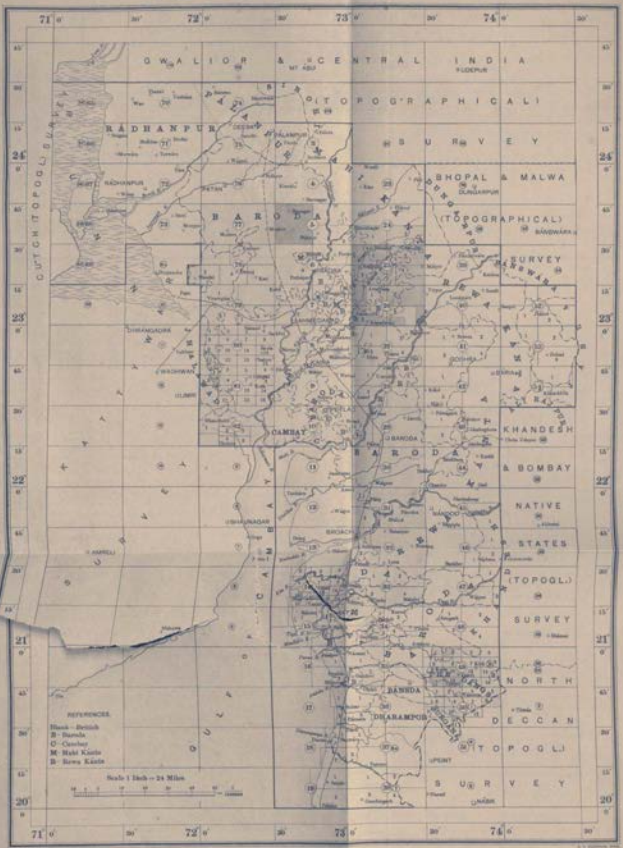
72. The survey of the Dang forests, on the scale of 4 inches to a mile, has made considerable progress. The topography was only commenced last year,

* Major Thuillier reports that his assistants have one and all worked with much zeal and energy both in the field and in the recess season: that the recess duties were unusually heavy but the whole party cheerfully worked during extra hours throughout the season.

† Lieutenant Gore was withdrawn on the 3rd January to proceed to Quetta and join the column there, and Mr. Warwick, who only joined on the 13th January, was compelled to go on sick leave after completing the topography of an insignificant area, being attacked with jungle fever in the Dangs.

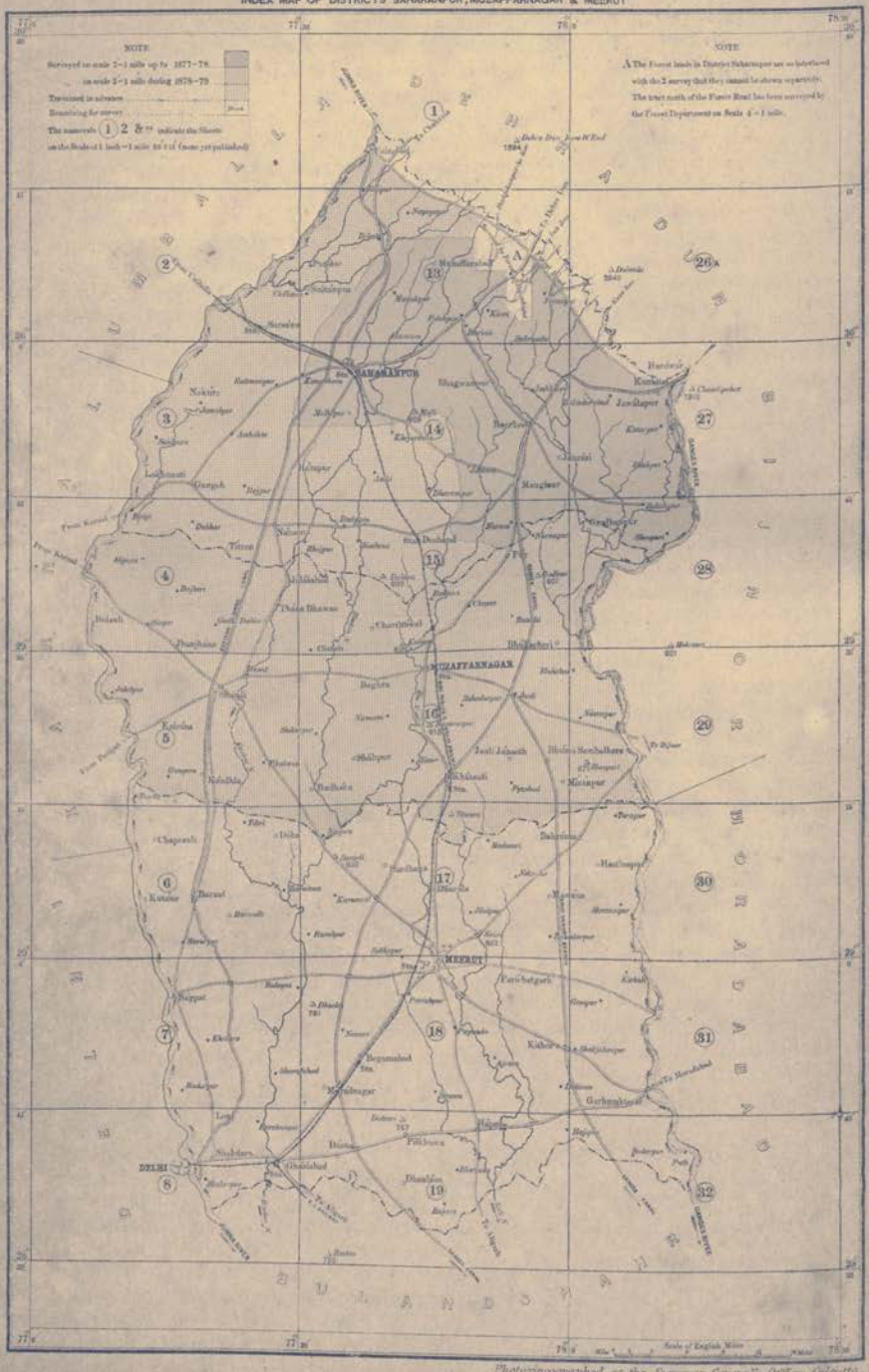
SURVEY OF INDIA.

INDEX CHART of the GUZERAT SURVEY.



N.W. PROVINCES SURVEY

INDEX MAP OF DISTRICTS SAHARANPUR, MUZAFFARNAGAR & MEERUT


NOTE
Surveyed on scale 2=1 mile up to 1877-78.
on scale 2=1 mile during 1878-79.
Traversed in advance
Remaining for survey
The numerals (1) (2) &c indicate the Sheets on the Scale of 1 inch=1 mile 26 x 21 (none yet published)
NOTE
A The Forest lands in District Saharanpur are so interlaced with the Z survey that they cannot be shown separately. The tract south of the Forest Road has been surveyed by the Forest Department on Scale 4=1 mile.
SAHARANPUR
MUZAFFARNAGAR
MEERUT
DELHI
Scale of English Miles

Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B.-R.E.-F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, March 1880

and two contiguous sections, each $7\frac{1}{2}'$ longitude by $3\frac{3}{4}'$ latitude were published, lying east and west of each other in the north-west quarter of the Dangs. Of these, the westernmost was not quite a full section, as the western boundary of the Dangs crosses it, and the country outside the boundary was not surveyed. This year, four sections lying immediately south of the two published last year, and one section immediately to the north of the west section of last year, have been mapped and are ready for publication, and one plane-table (half a section) was surveyed contiguous to and to the east of the northern section; but the other half section could not be completed on account of the surveyor being attacked with jungle fever and having to leave the district. The total area surveyed, was 145 square miles. An area of about 450 square miles has been prepared for survey, but perhaps about 50 of this extends beyond the eastern boundary of the Dangs. About 200 square miles of the Dangs have now been topographically surveyed, and nearly 700 square miles remain for final survey.

73. The portion of the Dangs already surveyed, is one mass of hills of bold and complicated features and wild aspect, densely covered with forest trees, which makes the progress of the survey very tedious. The climate, too, is so unhealthy during the cold weather, that it is not considered safe to enter till 1st March, after which the most one Surveyor can turn out is one plane-table of about 17 square miles on the 4-inch scale, and therefore it will be necessary to send nearly the whole strength of plane-table Surveyors in the Party into the Dangs every hot weather, till it is completed.

74. The out-turn of area topographically surveyed on the 2-inch scale is less by 617 square miles, and that on the 4-inch scale is greater by about 100 square miles than in the preceding year. The diminution in the former is due partly to the increase in the latter, partly to the nature of the country, which was in many parts much wooded and intricate, causing the rate of progress to be very slow; and partly to the operations having extended eastwards into the belt of country which runs along the foot of the Ghâts, through the entire length of the province of Guzerat, and is very unhealthy, and can only be operated on with impunity during a short portion of the field season. But the survey of the Dang forests is the chief obstacle to the rapid progress of the general operations; it is on twice the scale of the surveys elsewhere, for which reason, and because the ground is extremely intricate and difficult, it takes four times as long for equal areas. Moreover, these forests lie in a notoriously unhealthy tract of country, which may not be entered until three-fourths of the field season is over; consequently the operations in them cannot be carried on continuously, and they disturb the continuity of the operations elsewhere, and cause the surveyors to spend a portion of the field season in the unprofitable occupation of travelling considerable distances between the localities which are brought under survey at different times of the year.

75. The area triangulated in advance for future topography was 1,596 square miles, fixing 668 stations, of 126 of which the heights were determined; the aggregate length of the lines traversed was 1,136 miles; the number of plane-table stations averaged 20 per square mile for the 2-inch scale and 56 for the 4-inch scale. The area of which the mapping has been completed and sent to the head-quarters' office at Dehra for publication, amounts to 1,650 square miles, and a further area of about 1,100 square miles is reported as nearly ready to be sent in.

XII.—SAHARANPUR AND MUZAFFARNAGAR SURVEY No. (3 REVENUE PARTY).

76. Throughout the year, this party, with an establishment of the strength noted in the margin, has continued under the control of Major Wilkins. The establishment having left recess quarters at Landour early in October, field work was commenced in Saharanpur by the 15th, and was continued up to the 18th May 1879.

Personnel.

Major W. H. Wilkins, Deputy Superintendent, 3rd grade, in charge.
Mr. E. C. Ryall, Assistant Superintendent, 3rd grade, joined on 4th January 1879.
Mr. James Todd, Surveyor, 3rd grade.
„ R. C. D. Ewing, Assistant Surveyor, 1st grade.
„ C. W. Wilson, „ „ 3rd „
„ C. W. F. Seyers, „ „ 3rd „
and 30 Sub-Surveyors, &c.

77. The chief part of the operations has been a topographical survey on the scale of 2 inches = 1 mile,—village boundaries being taken from the settlement survey maps and added by transfer to the topographical maps. An area of 1,549 square miles has been completed in this manner on the 2-inch scale, of which, 1,067 belong to Saharanpur

and 482 to Muzaffarnagar. In addition to which, the "Patri Forest" of District Saharanpur, area 22 square miles, has been surveyed on the 4-inch scale; Saharanpur city and civil station, area 13 square miles, has been surveyed on the 6-inch scale; and a line of villages of the Umballa District bordering on the Jumna River and adjoining the Saharanpur District, area 87 square miles, has been surveyed on the 4-inch scale; the total topography surveyed on all scales has thus been 1,671 square miles. An area of about 1,250 square miles in the Muzaffarnagar district has also been traversed in advance for the Topographical operations of the coming season.

78. The survey of Saharanpur District has been completed, with the exception of the village boundaries on the Jumna and Ganges Rivers, which will be adjusted and mapped during next field season. With regard to the Topographical Survey on the 2-inch scale, the Executive Officer reports:—

"This has been as minute as the scale would allow. All roads or cart tracks, masonry wells, topes of trees, as well as village sites, are shown; limits of jungle or grass lands, except unimportant patches, have been surveyed. Great attention has been shown to all drainage lines; and low ground has been carefully defined."

A reference to paragraph 197 of last report will show that a portion of the Saharanpur District containing forest reserves has not been surveyed by this Department. This portion still remains to be mapped on the Topographical Survey sheets by transfer from the maps of the Forest Department.

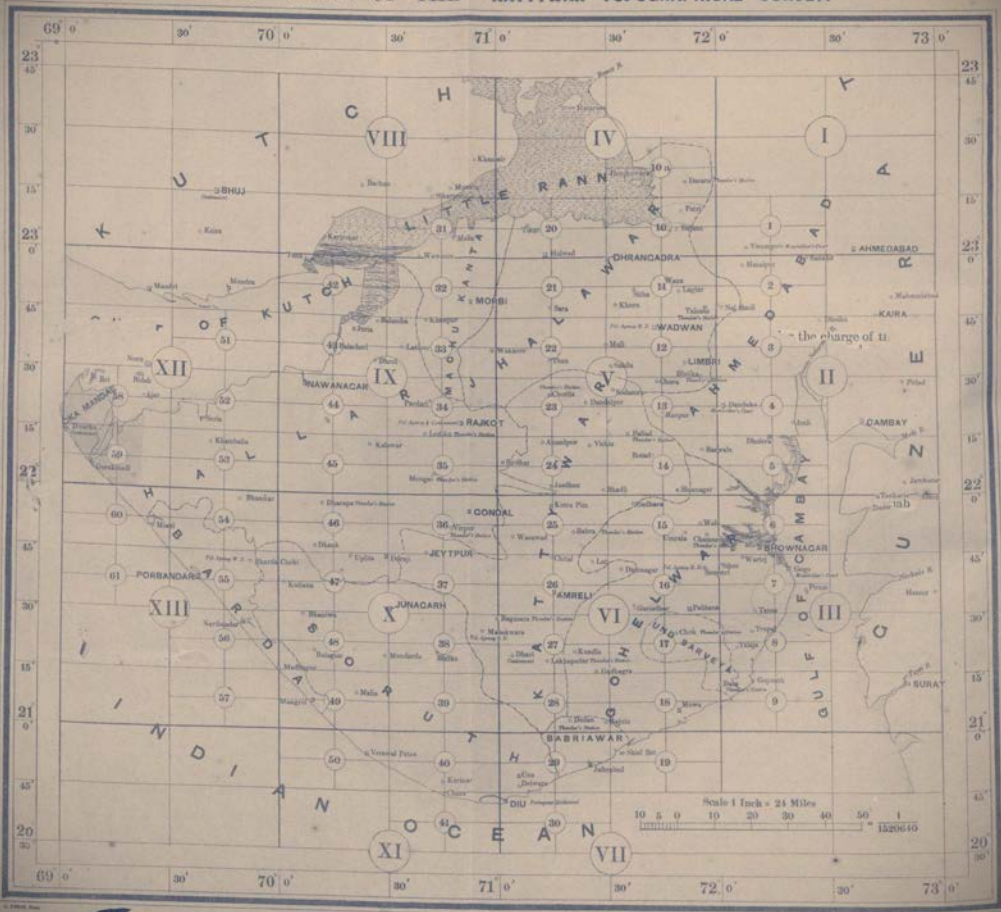
79. The Patri Forest consists of five blocks situated within Pargana Jawalapur of the Rookee Tahsil. The forest is under the charge of the Superintendent of the Canal Foundry at Roorkee, who having represented that he had arranged with the adjoining village proprietors to have the old irregular boundary lines converted into straight lines, a Sub-Surveyor was placed at his disposal, and the alterations have been made on the principle of "give and take." The new boundary, which has been shown on the maps, will be marked by a ditch and bank.

80. The survey of the line of river villages in the Umballa District has been undertaken with the following object:—The Punjab Government having expressed a desire to obtain accurate maps of the alluvial valleys adjoining some of the larger rivers, showing village boundaries and the present course of the stream, and thus to exhibit the accretion and decretion of lands since the former surveys were made; advantage was taken of the presence of this party in the Saharanpur District to carry out the wishes of the Punjab Government for the villages of the Umballa District bordering on the Jumna River and lying opposite to the District of Saharanpur. A special series of 4-inch maps of these villages has been prepared, on which the opposite villages of District Saharanpur have been projected, so as to provide a map of the entire alluvial tract. The survey of village boundaries has been made by direct inquiry from the people without the aid of previous demarcation by the Civil authorities, and, as a rule, the old boundaries were found to have been well preserved on the land beyond the action of the river; in the alluvial lands, many changes of boundaries were found to have taken place; but the old maps, being incomplete as to the boundaries in the river bed, did not afford a means of comparison in all cases. The disputes which were met with, and which still remain unadjusted, are chiefly on the district boundary, and are due to the disregard of the people to the rule of the deep mid-stream boundary; owners of villages, whose lands have decreted, claiming to cross the stream and to acquire possession of the new lands which have re-formed on the opposite bank. In some instances, these claims have been allowed by the opposite villages, but in others they are disputed. The Financial Commissioner of the Punjab has been addressed on the subject of the disputed boundaries, and also with regard to the extension of the special survey to the Jumna alluvial lands of the Kurnal and Delhi Districts. As the boundary of districts on the Jumna River is also part of the boundary between the Punjab and the North-Western Provinces, the Board of Revenue at Allahabad have also been addressed on the subject of the special survey. This subject is well worthy of the attention of the Governments of the North-Western Provinces and Punjab, while the Survey Party is still in the vicinity.

81. On the requisition of the Lieutenant-Governor of the Punjab, an Assistant Surveyor was deputed from this division during January 1879, to survey a portion of the boundary on the Ravee River between the Gurdaspur District and the territories of the Maharaja of Kashmir, at one time under dispute, but which

GREAT TRIGONOMETRICAL SURVEY OF INDIA.

INDEX CHART OF THE KATTYWAR TOPOGRAPHICAL SURVEY.



The numerals I, II, &c. indicate the sheets on the scale of one inch to the mile. The numerals I, II, III &c., indicate the degree sheets, on the Scale of 4 inch to the mile. The sheets are divided into 4 sections known as the N.E., N.W., S.E., & S.W., sections of the sheet, of these a few copies will be published on the Scale of the original survey, viz., 4 inches to the mile for the use of local officials.

Denotes country Topogr.

Surveyed up to 1877-78

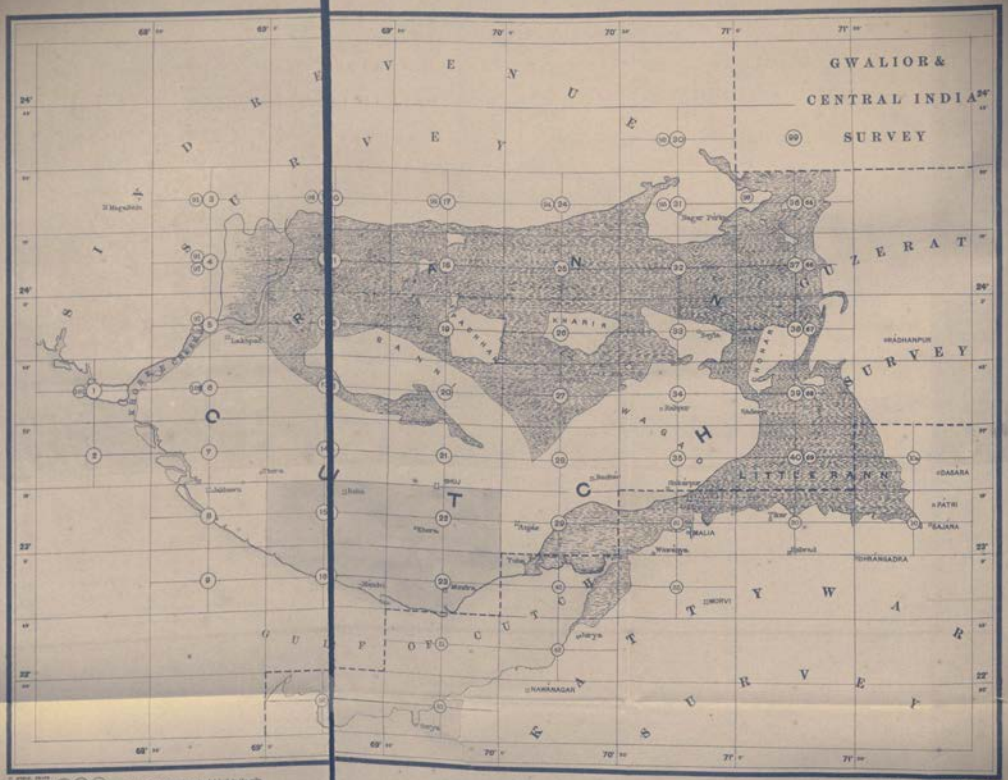
Triangulated in advance

to 1878-79.

Photolithographed at the Office of the Superintendent Great Trigonometrical Survey, Dehra Dun, October 1879.

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.



The numerals (1) (2) (3) &c., indicate the sheets on the scale of 1 inch to the mile.

The smaller numerals as (10) or (44) or (1) indicate the sheets of adjoining surveys.

The originals of the 1-inch sheets are drawn on the 6-inch scale and are divided into 4 sections,

known as N.E., N.W., S.E., and S.W.

Scale 1 inch = 10 miles 10 5 0 10 20 30 40 50 = 1/126720

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1879.

had recently been adjusted by arbitration. Mr. R. C. D. Ewing, Assistant Surveyor, was employed on this duty from 8th to 29th February 1879, and has submitted a map of the new boundary countersigned by Mr. R. T. Burney, the officer who effected the adjustment.

82. During the year 1879-80 the remaining area, 1,300 square miles, of Muzaffarnagar, and probably 300 square miles of the Meerut District, will be surveyed in detail.

83. With reference to paragraph 199 of last report, referring to the state of the trijunction platforms of villages in Saharanpur, the Executive Officer now reports that they are all in a satisfactory condition, having been re-built of good materials. In Muzaffarnagar, very few trijunction platforms were found in existence. The construction of the platforms was undertaken during the course of the survey, at first with very inferior materials, but on this defect being brought to the notice of the Collector, orders were issued to provide for their being built in a substantial manner. It is considered of importance that these marks should be constructed of durable materials, in order that fixed points, agreeing with the Topographical Survey traverses, may be available in the case of any future Settlement Surveys. It is also of importance that the platforms should be ready previous to survey, and timely intimation has been given of survey requirements in this respect for the Meerut District.

84. Connections have been made with 11 primary and 4 secondary stations of the Great Trigonometrical Survey, and the triangulation distances have been used as a means of correcting the errors of the measured traverses. As checks on the angular work, 64 observations for azimuth were taken; and to test the topography, 432 linear miles of check survey were surveyed by the Executive Officer and two of his Assistants. It is reported, with regard to the topography of the Sub-Surveyor's plans, that "the work has been proved to be very good and very minutely surveyed."

85. Two series of general maps will be published for all the districts of the North-Western Provinces now being brought under topographical survey. One series will be on the scale of 2 inches = 1 mile,—exact reproductions of the original surveys,—showing village boundaries, and of the standard size of $7\frac{1}{2}$ latitude × 15′ longitude. The second series will be on the scale of 1 inch= 1 mile, having the features somewhat generalized, without village boundaries, and of the standard size of 15′ latitude × 30′ longitude; this series will be drawn in an exaggerated style—on the 2-inch scale—for reduction by photography to the scale of publication. The country surveyed in Districts Saharanpur and Muzaffarnagar extends southwards to the parallel of 29° 12′, and is comprised in 23 2-inch standard sheets. These 23 sheets have been mapped, with the exception of the portions of the Saharanpur District, which are to be transferred from the Forest Survey maps. The exaggerated maps for reduction are in progress.

86. The office of the 3rd Division was inspected at Mussoorie during October. The field plans exhibit very careful surveying. The standard maps show that pains have been taken to ensure accurate transfers from the original plans; the drawing and typing are neatly executed, and the artistic style of the maps reflects much credit on Major Wilkins and on his well-trained establishment.*

XIII.—THE SURVEY OF KATTYWAR (KATHIAWAR) AND CUTCH.

87. The operations of the field season were conducted under the immediate supervision of Mr. J. McGill, Major Pullan being absent on furlough to Europe, from which he returned and resumed charge of the party at the commencement of the recess.

Personnel.

Major A. Pullan, S.C., Deputy Superintendent, 3rd grade.
Mr. John McGill, Officiating Assistant Superintendent, 1st grade (officiating) in charge.
Mr. F. Bell, Surveyor, 3rd grade.
„ N. C. Gwynne, Surveyor, 4th grade.
„ W. A. Fielding, Asstt. Surveyor, 2nd grade.
„ G. T. Hall, „ 3rd „
„ P. F. Prunty, „ 4th „
„ J. Keating, „ 4th „
Visaji Raghunath Godboli, Head Sub-Surveyor, and 10 other Sub-Surveyors.

88. The out-turn of topography comprises an area of 1,835 square miles; all surveyed on the 2-inch scale for reduction to and publication on the 1-inch scale.

* Major Wilkins reports as follows of his assistants:—
"Mr. E. C. Ryall and Messrs. Todd and Ewing have given valuable assistance.
"Messrs. Wilson and Seyers have given satisfaction this year.
"Eight Sub-Surveyors have done good service, *viz.*, Nundlal Chatterjee, Kedar Nath, Bhugobutti Churn Chuckerbutti, Nijabut Hossein, Hidayatulla, Aladad Khan, Irfan Ali, and Boithram."

The operations lay principally in the Hallar and the South Prants of the province of Kattywar, and embraced an area of about 500 square miles in the inhospitable and very difficult hill tract appertaining to the Gir, the well-known refuge for outlaws and marauders from all parts of the country. The survey of the Gir was a part of the programme of operations for the previous field season, but it had to be abandoned, because the streams had dried up owing to the failure of the monsoon rains, and the country was deserted by its few inhabitants. This year the rainfall had been ample, but it was succeeded by a most unhealthy season, the people of the surrounding country dying in thousands, 60,000 being said to have perished in the months of September, October, and November alone. The Gir, being notoriously malarious and unhealthy at the best of times, was quite deserted, except at a few hamlets round its borders. The Surveyors could not be sent into it until the field season was far advanced; they were therefore employed at first in other parts of the District, and when the month of March arrived, they were massed together and sent into the Gir in a body; they succeeded in accomplishing the survey in about six weeks, and fortunately with fewer casualties than might have been anticipated.

89. The triangulation in advance of the topography, covered an area of 476 square miles in Kattywar, and a further area of 884 square miles in the sister province of Cutch, the survey of which is being taken up now that that of Kattywar is approaching completion. 417 points were fixed by this triangulation; 464 miles of boundary and check lines were traversed during the season. The number of plane-table stations for the topography averaged 12·9 per square mile. The whole of the mapping has been completed up to date, and sent to head quarters for publication.

90. There now remains in Kattywar only 480 square miles of ground to be topographically surveyed; it is mostly situated in the Okamandal District, which is under the Government of Baroda; it should be readily completed, together with a considerable area in Cutch, during the next field season.*

XIV.—AHMEDNAGAR AND POONA COLLECTORATES, NORTH DECCAN (No. 10 REVENUE PARTY).

91. This establishment left its recess quarters at Poona on the 15th November 1878, under the immediate orders of Mr. G. H. Cooke, Assistant Superintendent, 2nd grade, and at once commenced operations in the country that had been traversed in advance. On his return from furlough, Colonel John Macdonald, Deputy Superintendent, 2nd grade, was appointed to the charge of the party, and he relieved Mr. Cooke on the 6th May; but the field season had then almost come to a close, and to the latter officer the credit of the field arrangements and out-turn is consequently due.

Personnel.

Colonel John Macdonald, Deputy Superintendent, 2nd grade, in charge from 6th May 1879.
Mr. G. H. Cooke, Assistant Superintendent, 2nd grade, in charge up to 5th May 1879.
Mr. A. M. Lawson, Surveyor, 4th grade.
„ J. Newland, Assistant „ 1st „
„ G. C. Swiney „ „ 2nd „ transferred to 11th Division from 1st November 1878.
„ R. Dickinson, Assistant Surveyor, 3rd grade.
„ H. Corkery „ „ 4th „ transferred from Kattywar Party from 18th December 1878, and 19 Sub-Surveyors, &c.

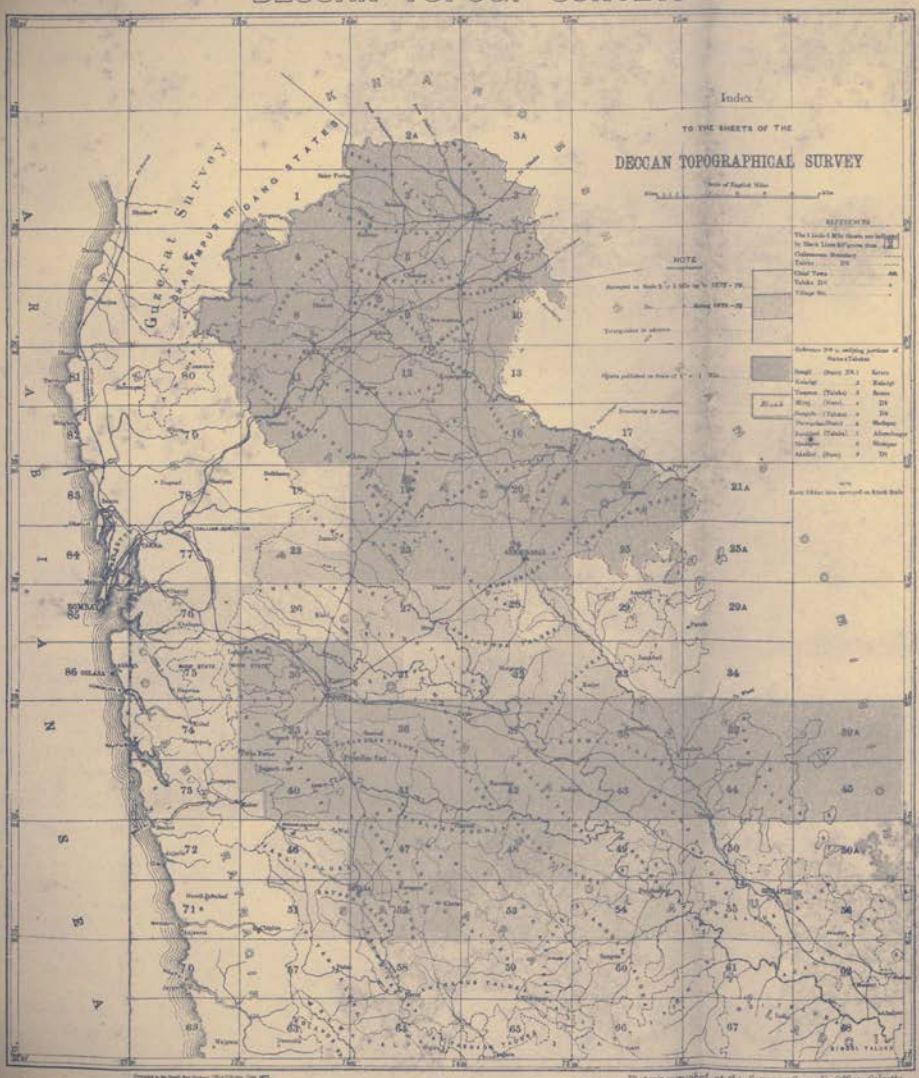
92. The area allotted for survey to this party having been nearly completed, it was necessary that a further field of operations should be provided, and, with the approval of the Bombay Government, the survey of the Konkan, or country lying between the Western Ghâts and the sea, was recommended. The proposal received the sanction of Government (see letter No. 43 of the 21st January 1879, from Secretary in the Department of Agriculture, Revenue, and Commerce,) and thus a sufficiency of work has been provided for both the Deccan parties for the next four or five years.

93. The same system of survey described in paragraphs 290 and 291 of last report has been followed, and the same scale, *viz.*, 2 inches to a mile, has been continued.

94. The country brought under topographical survey lies between latitude $\frac{18° 30'}{19° 15'}$ and longitude $\frac{73° 30'}{74° 30'}$ and includes an area of 2,215 square miles in Talukas Shrigonda, Karjat, and Jamkhed, of the Ahmednagar Collectorate, and in Talukas Khed, Sirur, Haveli, and Bhimthari of the Poona Collectorate. A detail survey of the town of Sangamner, on the scale of 66 feet to the inch, at

* Mr. McGill reports most favourably of Messrs. Gwynne, Fielding, Hall, Prunty, and Keating, and also of Ganesh Ram Chunder, and Narsú Dinkar, each of whom shared in the survey of the Gir; he also commends Mr. Bell for having accomplished a good out-turn of triangulation while suffering much from ill-health.

DECCAN TOPOGRAPHICAL SURVEY.



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Published under the direction of Major-General J.T.Walker, C.B-R.E-F.R.S., *Surveyor General of India.*

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the expense of the Municipality of the town, has also been completed, embracing an area of 380 acres. The triangulation has been extended in the Konkan over an area of 1,400 square miles, and the traversing in advance, necessary for the completion of the area remaining for survey above the Ghâts, has been completed.

95. The triangulation in the Konkan is based on the South Konkan meridional series of the Great Trigonometrical Survey; and four sides of the Great Trigonometrical Survey have afforded the means of checking the new triangulation, which has been found to be in error $1\frac{1}{2}$ inches per mile. The new triangulation has also been tested by the internal check of comparing the common sides of different triangles; in four large triangles, the average difference thus ascertained is 0·22 inch per mile, and in 156 smaller triangles, 3·81 inches per mile. The heights of 99 stations were determined trigonometrically by means of vertical angles; these also have been tested by the computation of the heights of the same points through different triangles, and the mean difference of height is 4·37 feet. A difficulty was encountered in carrying on the triangulation in the Konkan during the time when the agriculturists burn the village refuse to supply ashes for their rice fields; the smoke of the fires, added to the dense atmosphere near the sea coast, covered the tops of the hills with a dense haze, and after 10 in the morning even the luminous signals were not visible for over 6 or 8 miles. During next season, the triangulation in the Konkan will be completed before the burning commences. The Deccan dacoits were then roaming about the country and disturbed the arrangements of the parties engaged on the triangulation; on one occasion, they detained two signallers for a short time, and also caused considerable inconvenience by cutting down signals and destroying marks.

96. The topography in the plains has been checked by 268 linear miles of check survey, all measured by the Surveyors and the Assistants with the exception of 20 miles by a Sub-Surveyor; in the hilly parts, where chaining was not practicable, the field plans have been examined *in situ*.

97. The measured traverses have been corrected to agree with the triangulation distances, and the chain measurements were found to have an average error of 5·2 links per 100 chains, or $2\frac{3}{4}$ feet per mile.

98. The mapping has been done on the scale of survey, but prepared for reduction by photography to half scale, so that four 2-inch sheets may make up one standard-sized 1-inch sheet of 30′ longitude × 15′ latitude. Sheets Nos. 27, 28, and 32 have been completed, and are available for immediate publication. A reduction to the four mile scale, prepared as a guide to the engravers of the sheets of the atlas of India, has also been drawn. Skeleton maps of the country, showing all triangulation points, the trijunctions and the boundaries of villages, have been prepared for the Bombay Revenue Survey; and copies of the numerical values of the traverses have also been furnished to the same department.

99. During the ensuing season, it is expected that the survey of sheets 22, 29, 29A, 33 and 34 will be finished, and that some topography in the Konkan will be surveyed in sheets 75 and 76. Triangulation and traversing will also be extended northward, commencing in sheet 77. The area remaining for survey north of the parallel of 18° 30′ (which is the dividing line between the North and South Deccan parties) is about 5,000 square miles.

100. Captain E. W. Samuells was in charge of this party up to the 11th September 1878, when he availed himself of two months' privilege leave to recruit his health. Before the termination of his leave, the Afghan war had commenced, and survey officers being required to accompany the Khyber Column, he and Major Tanner were selected for the duty. Captain Samuells, after narrowly escaping from the enemy's artillery fire while surveying the Khyber Pass, during the battle of Ali Musjid, fell a victim to fever on the 21st December 1878. His loss is much to be deplored, as he was at all times an energetic, zealous, officer. He entered the Department in December 1863, and although he never attained to the grade of Deputy Superintendent, yet he held charge of different parties for periods aggregating six years; and had served in Bengal, Assam, the Deccan, and on a special boundary survey of the frontier line between Oudh and Nepal.*

* Colonel Macdonald reports very favourably of Messrs. Cooke, Lawson, and Dickinson, and commendably of Messrs. Newland and Corkery, and several of the Native Sub-Surveyors; he observes of Mr. Cooke that he was in charge of the party throughout the field season and until the beginning of May, and deserves full credit for his administration, his accuracy as an observer, and his skill as a draftsman.

XV.—POONA, SHOLAPUR, AND SATARA COLLECTORATES, SOUTH DECCAN (No. 11 REVENUE PARTY).

101. On the withdrawal of Major Tanner for employment with the Khyber Column of the Afghanistan Field Force on the 27th October 1878, Major H. S. Hutchinson received over charge of the party and has since continued in charge. The establishment left recess quarters on the 15th November and remained in the field till the end of May. Field operations have been carried on chiefly in the Sholapur District, between latitudes $\frac{18°}{18°}\frac{0'}{35'}$ and longitudes $\frac{75°}{76°}$, in sheets 49, 50, 53, and 54.

Personnel.

Major H. C. B. Tanner, Deputy Superintendent, 3rd grade, in charge up to 26th October 1878.
Major H. S. Hutchinson, Assistant Superintendent, 2nd grade, in charge from the 27th October 1878.
Mr. S. M. Smylie, Surveyor, 3rd grade.
„ J. T. U. Coxen, Assistant Surveyor, 2nd grade.
„ G. C. Swiney, „ „ „ „
transferred from 10th Division, from 1st November 1878.
Mr. W. H. Penrose, Assistant Surveyor, 2nd grade.
„ G. A. Knight, „ „ 4th „
transferred from Mysore Topographical Survey from 1st October 1878, and 19 Sub-Surveyors, &c.

The system of survey is similar to that of previous years, the plane-table survey being based on previously executed triangulation and traversing. The 2-inch scale has also been continued for the greater part of the area; but for sheet 54, at the request of the Bombay Government, it has been increased to 4-inch, for the use of the Irrigation Branch of the Department of Public Works, by which Department the extra cost of the survey on the larger scale has been paid.

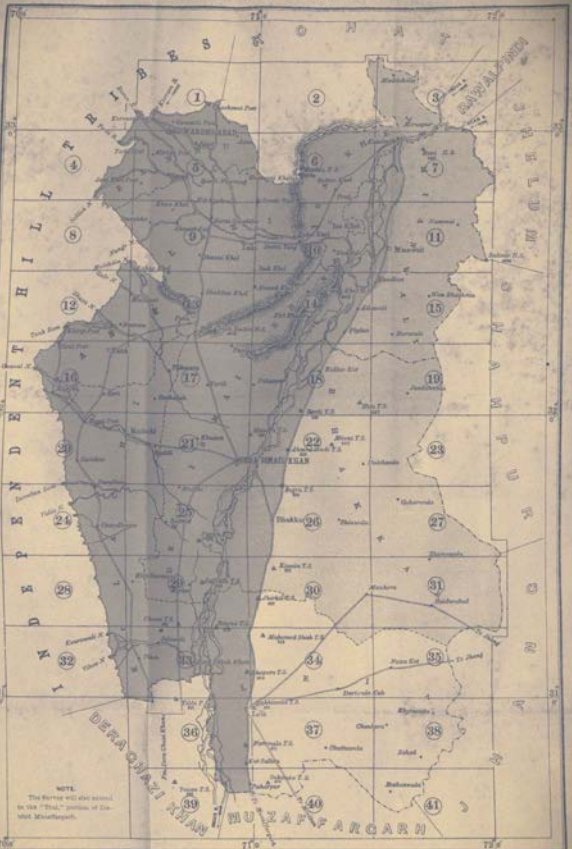
102. The topographical area surveyed on the 2-inch scale is 1,402 square miles, and on the 4-inch scale, 576 square miles. Satara city, in area 1,450 acres, has been surveyed on the scale of 80 inches=1 mile, at the expense of the Municipality. The topographical area completed this year, is in defect 445 square miles when compared with that of the previous year; this is chiefly due to the substitution of the 4-inch for the 2-inch scale in part of the area, and possibly also to the fact that Major Hutchinson was unable to utilize any of the topography of the Bombay Revenue Survey maps, as was done by Major Tanner in the previous year, and reported on in paragraph 306. On this point Major Hutchinson reports as follows:—

"The 2-inch work has been conducted in exactly a similar manner to that of former seasons, with the exception that no items beyond boundaries and roads have been derived from the Bombay village maps. It has been found by experience that the drainage and other items are so imperfect and vary so much in quality in different localities, according to the time at which the survey was done and the officer who did it, that I have not considered it wise, with the supervision at my disposal, to carry on its utilization. The village survey might doubtless be further turned to account with greater means of superintendence, but it then becomes a question of expenditure, and I am inclined to think much would not be gained in this respect, whilst a certain amount of uncertainty must remain, unless every portion of the work be checked and gone over on the ground; at any rate, with the establishment at my command, I have not felt myself justified in making further use of it this season."

103. The object of the 4-inch survey was to place in the hands of the Irrigation Department, for purposes connected with one of their large projects, an accurate map of the country shewing the limits of the cultivators' fields. To accomplish this, the topography was surveyed on the increased scale, and village boundaries with field limits were introduced from the existing Bombay village maps. For the transfer of field limits, the Surveyors fixed the corners of fields at distances averaging 60 chains apart, and recorded the numbers of the fields meeting at these points. Lines were drawn between these points so as to form similar triangles on the topographical and on the village maps, and within these triangles the fields were transferred by means of proportional compasses. All errors in the position of the fields on the village maps were thus confined within the triangles. The 4-inch maps for the Irrigation Department are of similar dimensions to the standard maps on the 1-inch scale. They each embrace an extent of country $3\frac{3}{4}'$ latitude by $7\frac{1}{2}'$ longitude, and have been projected so that 16 sections make up the standard sheet No. 54 on the 1-inch scale. The maps will be reproduced by photozincography, 200 copies of each being required by the Irrigation Department. In addition to the 16 4-inch maps of the country included in sheet No. 54, the usual maps on the 2-inch scale have also been prepared for reduction and for the publication of the sheet with the others of the 1-inch series. The charge to the Irrigation Department for this work has been Rs. 2,688, which sum has approximately

PUNJAB SURVEY

INDEX MAP OF DERA ISMAIL KHAN & BANNU DISTRICTS.



Surveyed on Scale 4 = 1 mile up to 1877-78 ..... Scale of English Miles

" during 1878-79 .....

Triangulated and Traversed in advance Do .....

Remaining for Survey ..... (Shaded)

The numerals (1) (2) &c. indicate the Sheets 36 X 45 on the Scale of 1 inch = 1 mile (none yet published)

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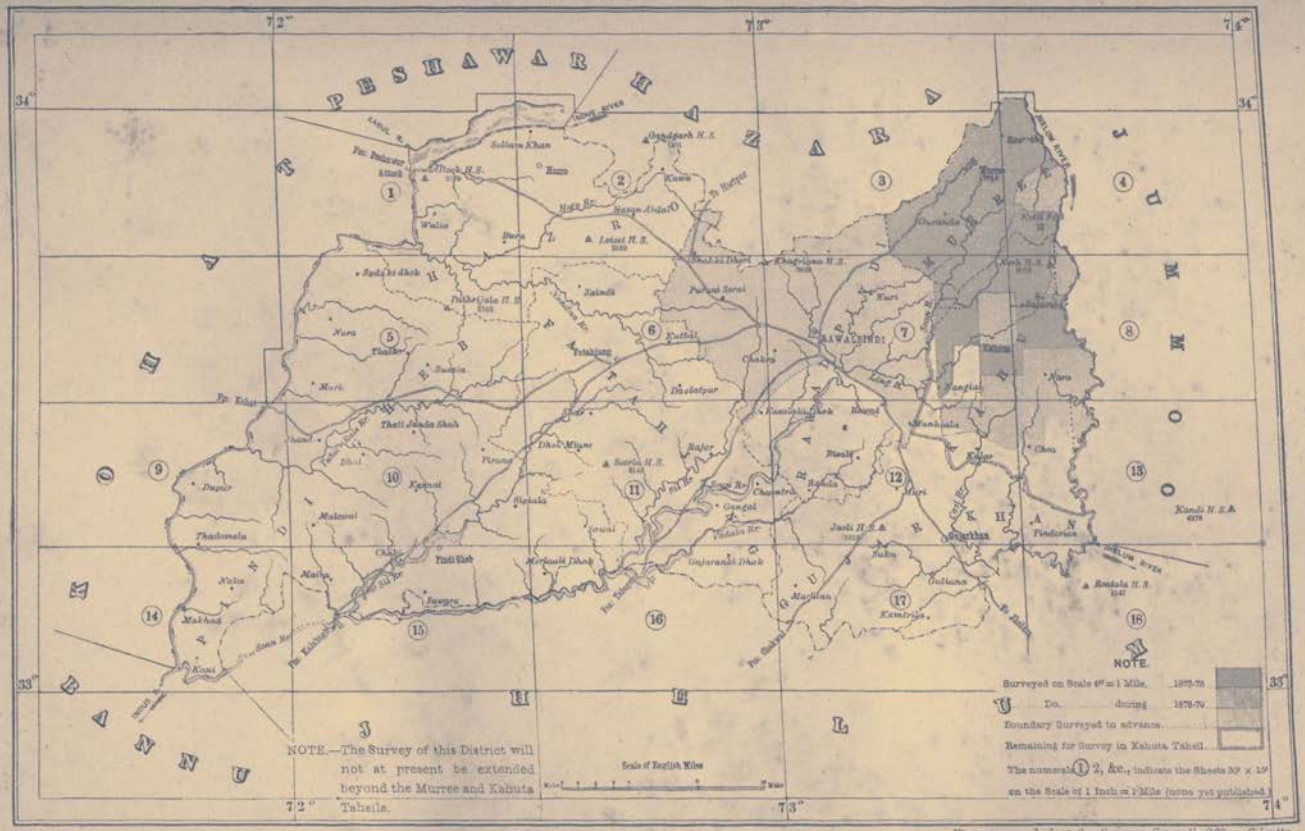
PUNJAB SURVEY.

INDEX MAP OF RAWALPINDI DISTRICT SURVEY.



NOTE.—The Survey of this District will not at present be extended beyond the Murree and Kahuta Tahsils.

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covered the actual extra cost of survey for the increased scale and preparation of the additional maps; but no charge has been made for superintendence or for other indirect expenses, nor has any count been taken of the future expenditure which will have to be incurred by the Survey Department on account of the defect of the 2-inch area; this loss of area has been considerable, and should any further work be required on the 4-inch scale, a higher charge will have to be made.

104. The triangulation has been advanced over 2,388 square miles, and has consisted of the introduction of subordinate triangles within the large triangles of the Great Trigonometrical Survey, which had conveniently been extended over the entire area. The sides of the small triangles are from 5 to 6 miles in length, and the average error of the minor triangulation on comparison with the direct distances of the large triangles is 1·8 inches per mile. Connections on the sides of the minor triangulation of previous years shewed a difference of 2·3 inches per mile. Subordinate to the minor triangulation are the chain traverses which have been measured to fix the trijunctions of villages with greater accuracy than could have been done with the plane-table alone, as well as to furnish additional points for the plane-table survey. They are taken in the first instance from one triangulation station to another; and from these main traverses, other cross traverses are taken as may be required. The average error of the chaining on the traverses, on comparison with the direct distances of the triangulation, was found to be 2·4 feet per mile.

105. Azimuths for the minor triangulation, and for the traverses, have been derived from the rays of the Trigonometrical Survey without further necessity for astronomical observations. The topography has been tested by the measurement of 216 linear miles of check survey, the comparison of which with the plane-table sections, it is stated by Major Hutchinson, "agrees very satisfactorily indeed;" it is further added that the check surveys through the 4-inch work noted the intersections of the field limits, and that these, as introduced on the final maps from the village plans, were found to "tally remarkably well."

106. The heights of 59 points have been trigonometrically determined, and of 24, the results have been checked by independent computations through different triangles with an average difference of 4·6 feet. In sheet No. 53 the bench marks of the "Mán" irrigation scheme have been connected on and the levels are entered on the map.

107. During the coming season, the Topographical Survey will be continued in sheets 50, 50A, 55 and 56, and large scale surveys of the two muncipal towns of Sholapur and Pandharpur, which fall within those sheets, will be undertaken. The area remaining for survey by this party, including the Konkan, and adopting latitude 17° as the southern limit of the survey, is about 11,800 square miles.*

MOUZAWAR OR VILLAGE SURVEY.

XVI.—DERA ISMAIL KHAN, BANNU, AND RAWALPINDI DISTRICTS (No. 1 REVENUE PARTY).

108. From the time of Major-General Johnstone's retirement, which was notified in paragraph 180 of last report, Captain H. L. Smith has held charge of this Division. During the year 1878-79, operations have been continued in the Dera Ismail Khan and Bannu Districts of the Derajat, as also in the Rawalpindi District. The field parties left recess quarters on the 15th October, and commenced field work immediately on reaching their respective localities. Field work was closed in the Derajat on the 25th March, and in Rawalpindi on the 30th June.

Personnel.

Captain H. Lees Smith, Assistant Superintendent, 1st grade, in charge.
Mr. G. Housden, Surveyor, 1st grade.
" W. S. Buttress, Surveyor, 4th grade.
" A. J. Gibson, " " "
" R. Todd, Assistant Surveyor, 1st grade.
" P. A. Peters, " " 4th "
" J. C. Kelly, Probationary Assistant Surveyor, 4th grade, appointed from 11th October 1878, and 22 Sub-Surveyors, &c.

* Major Hutchinson reports very favourably of Mr. S. M. Smylie, "to whose forethought and valuable assistance in the immediate supervision of the traverse work, the out-turn of work for the season is greatly to be ascribed;" he also commends Messrs. Coxen, Swiney, Penrose, and Knight, and most of his Native Sub-Surveyors.

109. The following is an abstract of the season's out-turn :—

Districts.	Sub-Divisions.	Areas surveyed.		Scale.
		Topography.	Boundary traverses.	
Dera Ismail Khan	Pargana Bhakkar ...	469·5	...	4 inches=1 mile.
Bannu	„ Isakhel ...	189·0	...	
	„ Meanwali ...	1156·7	...	
Rawalpindi	Tehsil Murree and Kahuta ...	206·5	...	
	„ Rawalpindi ...	...	451	
Shahpur	Sakesar Sanatarium ...	1·6	...	16 inches=1 mile.
	Total ...	2023·3	451	

The survey of the Bannu District has been completed during the season.

The area of 451 square miles traversed in advance in Rawalpindi will not be completed in detail, owing to the recent orders conveyed in letter No. 459, dated 3rd October 1879, from Secretary, Government of India, Home, Revenue and Agricultural Department, limiting future operations to the hilly portions of the District where forest demarcations are being carried on.

110. Captain Smith reports that—

"The whole of the work completed in the Murree and Kahuta Tehsils of Rawalpindi lay in the mountainous tracts of the north-east of the district, and was a laborious task; the cultivation in these hills is so interlaced with the forest, that the taking up of the minute details which so large a scale demands is a matter of considerable difficulty. The Banghi Khel Hills situated between the Indus and the southern boundary of the Kohat District, being extremely precipitous and rugged, required careful survey. The hills of the salt range extending from Kalabagh on the Indus to Sakesar in the Shahpur District were easier of survey. The rest of the work in the Derajat was easier than the average, especially in the *Thal*, where the details were few and simple."

111. The area remaining for survey is described as follows :—

"The programme for next field season is the completion of the hill work in the Murree and Kahuta Tehsils of the Rawalpindi District, giving about 360 square miles; the completion of the interior survey of Bhakkar Tahsil of the Dera Ismail Khan District, an area of 1,417 square miles; the traversing in advance of the Leia Tahsil of the Dera Ismail Khan District, an area of about 1,850 square miles; and the traversing in advance of the *Thal* portion of the Muzaffargarh district, about 900 square miles."

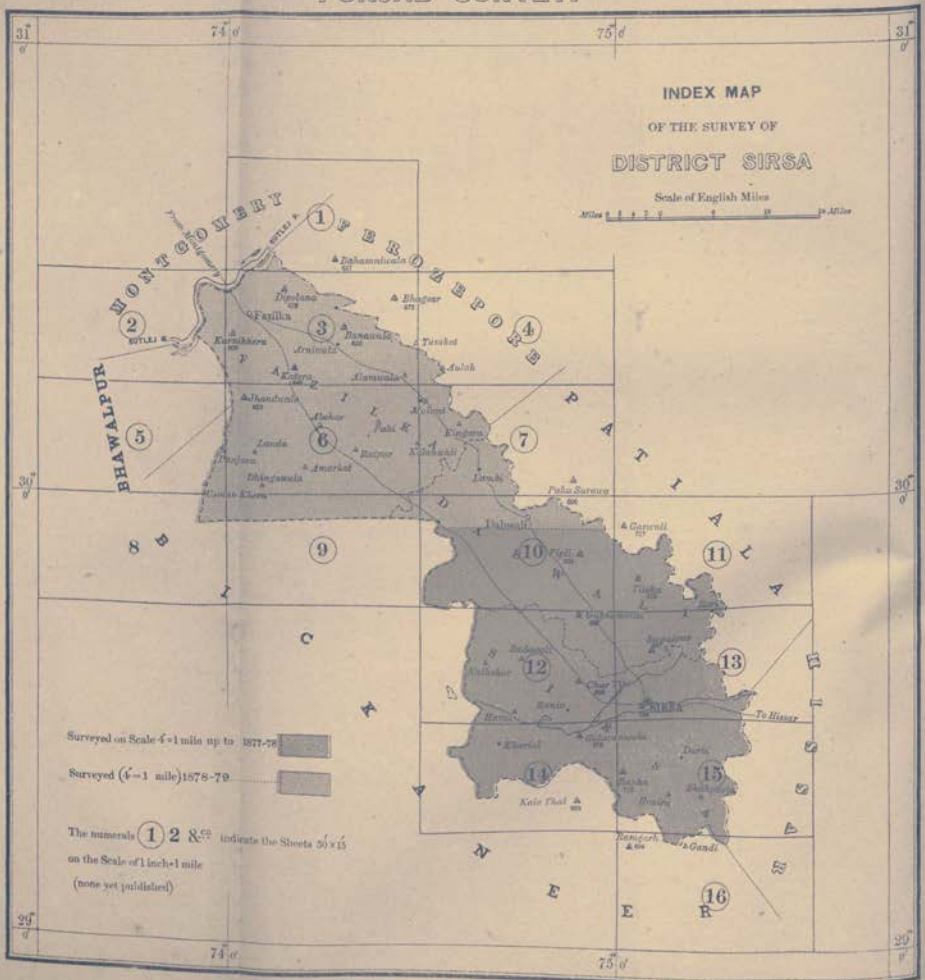
112. In the Rawalpindi District, two stations of the Great Trigonometrical Survey have been connected with the measured traverses, which has shown the chain measurements to have an average error of 3·25 feet per mile. Azimuth observations have been taken at 28 stations. To test the accuracy of the topographical details in Bannu and Dera Ismail Khan, 138 linear miles of check survey were measured; the comparison of these check surveys showed that the survey had been carefully done. In the hills of Murree and Kahuta, the field sheets surveyed by the Sub-Surveyors were checked *in situ* by the European Assistants when surveying the hills.

113. The drawing of 90 4-inch sheets, which include the entire out-turn of the season in Districts Bannu and Dera Ismail Khan, has been completed, as well as duplicate copies for record in the offices of the Deputy Commissioners. The topographical area in Rawalpindi is included in 22 sheets, of which ten have been drawn. The survey and mapping of Murree Sanatarium in seventeen sections, on the scale of 20 inches=1 mile, have been finally completed, and the map is under publication on the scale of 10 inches=1 mile in a series of six sections.

114. The settlement maps of the villages situated in the plains of Bannu, Dera Ismail Khan, and Rawalpindi Districts were very good, and the boundaries were found to agree well with those surveyed by the professional survey. In the salt range of hills in the Bannu District, the demarcation was defective. In the Murree and Kahuta Tehsils of the Rawalpindi District, the settlement maps were found to be very inaccurate representations of the boundaries according to the marks found on the ground; the demarcation was also defective, and much difficulty attended with delay was experienced in adjusting the village boundaries in those Tehsils.

115. The office of the 1st Division was inspected at Murree during September. The drawing of the sheets of the Bannu and Dera Ismail Khan Districts was found to be progressing favourably, and the work neatly executed. The

PUNJAB SURVEY.



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progress of the sheets of the Murree and Kahuta Tehsils of the Rawalpindi District for the Forest Department had not been so rapid as had been expected, as the drawing of hill features in a mountainous country, on the large scale of 4 inches to a mile, had proved to be very laborious. The work, however, was being executed with considerable artistic skill, and steady progress was being made.*

XVII.—SIRSA AND JHELUM DISTRICTS (No. 2 REVENUE PARTY).

116. The charge of this survey has been held throughout the year by Lieutenant-Colonel D. Macdonald. One section of the party left recess quarters at Landour during October 1878, and proceeded to resume the 4-inch survey of the Sirsa District. Field work was commenced on the 24th October, and was continued till the 24th March; the work of the season for this section of the establishment was then finished, and the survey of the Sirsa District (commenced in 1876) completed.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent, 2nd grade, in charge.
Mr. M. E. Loftie, Surveyor, 2nd grade.
„ G. H. Blyth, „ „ „
„ F. Grant, „ „ „ transferred from No. 6 Topographical Party, and joined on 6th June 1879.
Mr. P. Ford, Assistant Surveyor, 1st grade.
„ J. Hickie „ „ 2nd „ transferred from 1st November 1878.
Mr. B. Anderson, Assistant Surveyor, 2nd grade, on furlough from 23rd May 1879, and 33 Sub-Surveyors, &c.

117. The area surveyed in Sirsa is 1,396 square miles, exclusive of an overlap survey, also on the 4-inch scale, of one mile beyond the boundary in the adjoining Districts of Ferozepore and Montgomery, and in the States of Bahawulpore, Bickaneer, and Patiala, embracing an additional area of 177 square miles.

118. The season's operations included the whole of the Fazilka Tehsil and a portion of the Dabwali Tehsil. The country is said to be very open, without any high grass or heavy jungle. The details of cultivation, &c., were, however, rather intricate, especially in the neighbourhood of the Sutlej.

119. The executive officer reports that the work was carefully tested with the most satisfactory results. The Sub-Surveyors were all visited in the field and their work inspected. An Assistant Surveyor measured 261 linear miles of check survey; and the comparison with the field sheets shows that the work has been done most carefully and accurately.

120. During recess, all maps and area records of the Sirsa District have been completed. The 4-inch maps of the season's out-turn have been drawn, and reductions were then made to the 1-inch scale suitable for reproduction by photography. A reduced map of the whole district, on the scale of the Atlas of India (4 miles = 1 inch nearly) has been prepared to be used as a guide to the engraving of the sheets of the atlas. Copies of the 4-inch maps have also been prepared for record in the office of the Deputy Commissioner of the District.

121. The second section of the establishment was organized to commence the village survey of the Jhelum District, in accordance with instructions conveyed in letter No. 103 S.C., dated 18th September 1878, from Secretary to Financial Commissioner, Punjab; and field operations were begun in this new District on 15th November. The work in Jhelum consisted in the traversing of the boundaries of villages and *rakhs* (Government forest reserves) in advance for a detail survey; and an area of 455 square miles, included in 366 villages, has been surveyed in this manner. Skeleton boundary maps of these villages on the 4-inch scale have been plotted; but in accordance with the orders of Government, conveyed in letter No. 459, dated 3rd October 1879, from Officiating Under Secretary to Government of India, Home, Revenue, and Agricultural Department, the survey of the Jhelum District will not at present be continued. Several difficulties presented themselves in carrying out the village boundary survey, and the area of traverse work which had been proposed could not be accomplished. *First;* in the alluvial lands in the valley of

* Captain Smith reports of his Assistants as follows:—
Mr. G. Housden, "who is about to retire on a pension, is one of the oldest Surveyors in the Department, and during his long service of 33 years has done most valuable work for Government."
Mr. W. S. Buttress "has conducted the duties of the boundary camp to my great satisfaction."
Mr. A. J. Gibson "has spared no pains in his exertions in charge of the work in Murree and Kahuta, and has produced a most artistic map of the Murree Sanatarium."
Messrs. R. Todd and P. Peters "have done well and conducted their duties most creditably."

the Jhelum River, the villages are small, the boundaries are intricate with defective demarcation, and the villagers were very backward in pointing out the limits of their lands. *Second*; beyond the valley of the Jhelum, the country is intersected by deep ravines, and there are numerous rugged hills; in such ground, accurate chaining could not be prosecuted, and triangulated distances had largely to be substituted for chain measurements. The traverse survey has been connected with four stations of the Great Trigonometrical Survey and with eight stations of Colonel Robinson's Topographical Survey. The co-ordinate values of these stations have been made use of for correcting the errors in the measured traverses, and the required corrections show the traverses to have an average excess error of 2·3 feet per mile. Azimuths were observed at 19 stations to check the angular work.

122. The office of the 2nd Division was inspected at Landour during October. The maps and other records were then nearly completed, and all were found to have been prepared with great care. Lieutenant-Colonel Donald Macdonald had taken much pains to test each step of the office work by personal examination. The 2nd Division has since been brought under reduction in accordance with instructions conveyed in letter No. 516, dated 7th November 1879, from the Government of India, Home, Revenue, and Agricultural Department, and such of the members of the establishment as could be usefully employed elsewhere have been transferred to other divisions, and the remainder have been recommended for pensions or gratuities. Lieutenant-Colonel Macdonald has been appointed to the charge of the 1st Division.*

CADASTRAL OR FIELD SURVEY.

XVIII.—BANDA AND MIRZAPUR DISTRICTS (No. 5 REVENUE PARTY).

123. This party has continued throughout the year under the charge of Colonel Anderson. Field operations were resumed on the 1st November in Banda District and continued till the 15th April, when the establishment returned to Naini Tal, where recess duties were commenced on the 22nd idem.

Personnel.

Colonel F. C. Anderson, Deputy Superintendent, 1st grade, in charge.
Mr. E. J. Jackson, Assistant Superintendent, 2nd grade.
„ C. W. Campbell, Surveyor, 2nd grade.
„ E. G. Little „ 4th „
„ R. B. Smart, Assistant Surveyor, 1st grade.
„ G. W. Jarbo „ „ 2nd „ transferred to Julpigori Tea Grant Survey from 1st October 1878.
„ T. F. Freeman, Assistant Surveyor, 2nd grade.
„ H. G. Young „ „ 3rd „ transferred to Forest Department from 1st October 1878.
„ W. M. Kelly, Assistant Surveyor, 3rd grade, transferred from Forest Department from 1st October 1878.
„ E. P. S. Hill, Assistant Surveyor, 3rd grade, transferred from Leveling Party from 1st November 1878.
„ P. C. H. Smart, Probationary Assistant Surveyor, 4th grade, transferred to Leveling Party from 1st November 1878, and re-transferred to Professional Party from 1st June 1879, and 22 Sub-Surveyors, &c.

Temporary Establishment.

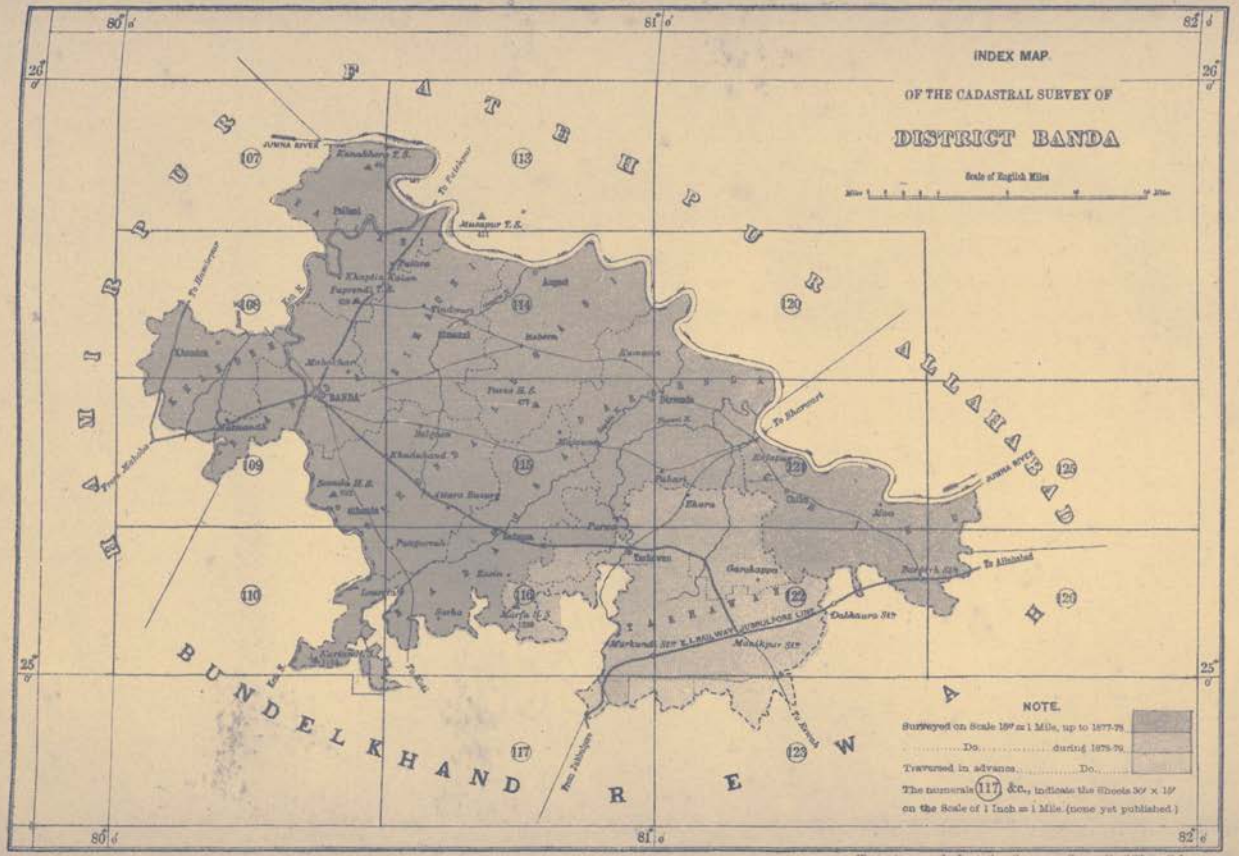
234 Field Surveyors and others.

124. The following table shows the area surveyed during the season in District Banda, with the nature of the work :—

	Cadastral Survey, 16-inch.		Topographical Survey 4-inch.		Remarks.
	Villages.	Area.	Villages.	Area.	
		Sq. miles.		Sq. miles.	
Tarhawan	183	409·1	...	...	(*a*) Includes 95·7 square miles re-surveyed of work done in 1876-77 and 1877-78.
Chhibu	163	126·5 (*a*)	...	...	
Badausa	27	43·6	...	...	
Kalinger	16	23·0	...	...	
Sihonda	...	1·7	...	...	
Forest Reserves	...	...	24	87·1	
Detached Villages of Independent Territory	...	...	40	61·4	
Total	389	603·9 (*a*)	64	148·5	

* Lieutenant-Colonel Macdonald reports, without particularizing the services of any, that "the whole establishment, both European and Native, have worked willingly and well, and done their utmost to turn out good and reliable maps."

N. W. PROVINCES SURVEY.



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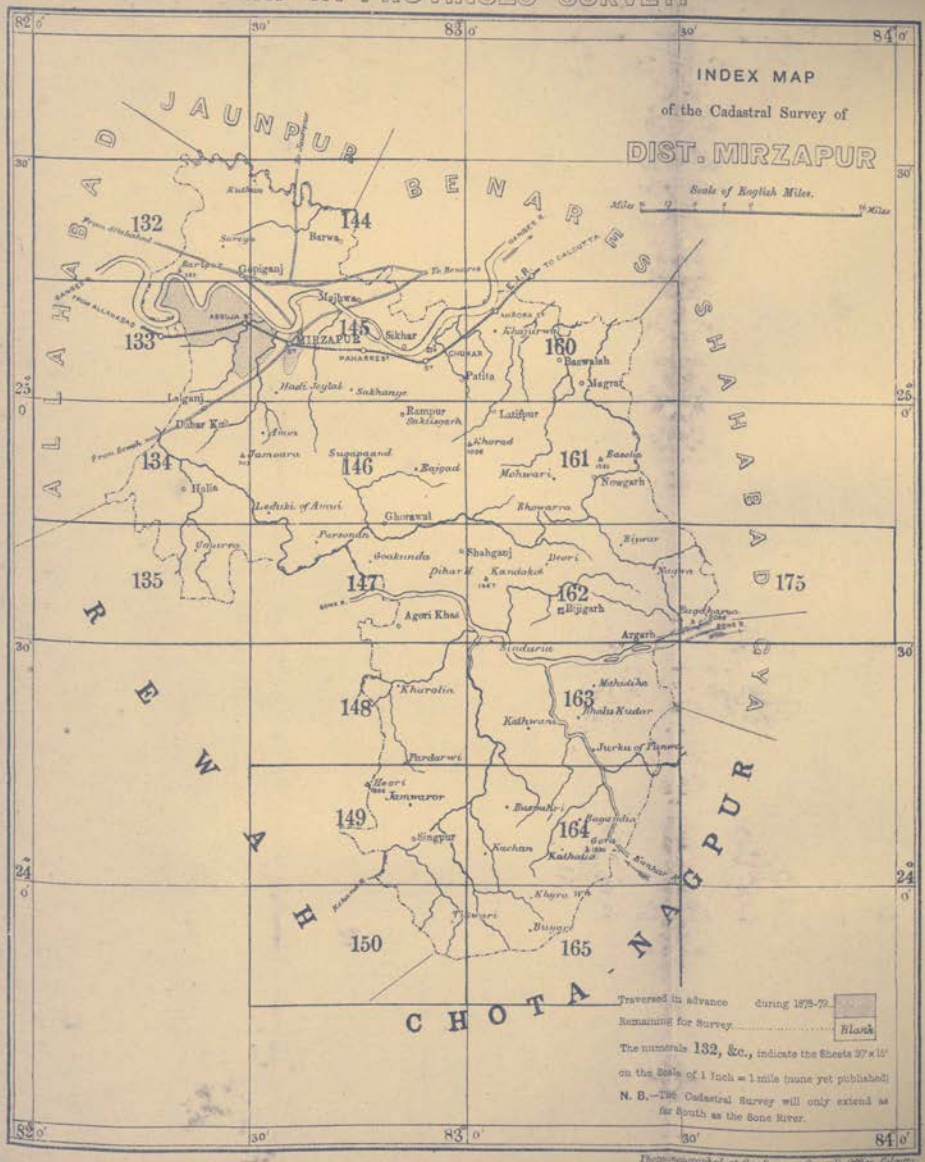

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In addition to the above, an area of 100·6 square miles of village boundary survey has been traversed in advance in District Mirzapur. The area returned as cadastral survey includes a large aggregate,—104 square miles,—of hilly country, which on account of the detached nature of the hills it has been necessary to map on the same scale as the cultivated portions of the village lands. No great delay was occasioned on the survey of the hills on this large scale as the hills were wanting in minute features; but the drawing of the hill sheets in office, in a style suitable for reproduction by photozincography proved very laborious, and an endeavour will be made in the survey of the Mirzapur District,—about to be undertaken by this division, and where a similar country will be met with,—to restrict the survey of the hills as much as possible to the 2-inch scale.

125. The survey of the forest reserves has been undertaken in accordance with instructions conveyed in letter No. 994F., dated 1st October 1878, from Under Secretary to Government of India, Revenue, Agriculture and Commerce Department. The area available for Government forests was then estimated at 250 square miles, which has now been ascertained to be about 100 square miles in excess of the true area that can be reserved. The survey has been done in communication with Mr. McConaghey, Magistrate and Collector of Banda, who is in charge of the forests, and who personally supervised the demarcation of the reserves. Tracings from the 4-inch sheets of the completed area of 87·1 square miles have been supplied to Mr. McConaghey, and it is expected that tracings of the remaining area, about 57 square miles, will be furnished during the early part of the field season.

126. In explanation of the necessity for making the re-survey of 95·7 square miles, Colonel Anderson reports as follows:—

"The Chhibu Pargana was surveyed in the field seasons of 1876-77 and 1877-78; but in November last Mr. Patterson, the Settlement Officer, brought to my notice that, owing to exceptional causes, such numerous and extensive alterations had occurred in the field boundaries that in many cases the plots on the maps could not be identified with the fields on the ground. The reasons assigned by Mr. Patterson for these changes are, that owing to the total failure of the *kharif* (rain crop) in 1877, tracts in which, as a rule, only *rabi* (winter crop) had been grown were in the following year brought under *kharif*, while waste lands had been broken up for *rabi*; that numerous patches on the edges of fields had been taken in, effacing the old boundaries; and finally, that the cultivated area having at the time of survey been unusually small, while the crop area of 1878 was the largest on record, the whole face of the country in the Chhibu Pargana had undergone such a sweeping change that out of 183 villages 20 only had escaped unaltered. Mr. Patterson also informed me that, failing some immediate step by which our maps could be made to show the existing state of cultivation, Settlement operations would be very seriously retarded. I therefore lost no time in detaching a small staff of Field Surveyors under the superintendence of one of our most able Inspectors, who, with the sanction of the Superintendent of Revenue Surveys, and with the approval of the Board of Revenue, were exclusively employed on the Chhibu revisions for the whole of the field season. The Inspector and his squad of Surveyors worked *pari passu* with the settlement staff, and thus Settlement operations progressed as uninterruptedly as if no revisions were required."

The revisions were commenced by correcting the survey plans and khusras to agree with the alterations on the ground, and 25,340 fields were re-mapped; but this method was found to be so laborious in re-adjusting the computations of areas, that the reverse method was adopted, of tracing out the old divisions where it was possible to do so; and the boundaries of 32,205 fields as surveyed, were restored on the ground. It was found necessary to revise the field areas in 280 sheets.

127. In Banda District, four hill stations of the Rewa Topographical Survey were connected with the chain traverses, which has given ten distances by triangulation for comparison with the measured distances; in four cases, the average error of the chaining is + 1·72 feet per mile, and in six cases the average error is — 0·44 feet per mile. In Mirzapur District, two principal and five secondary stations of the "Garwani Meridional Series" were closed upon, and the Trigonometrical co-ordinates have been made use of to correct the chaining error, which was found to average somewhat less than 1 foot per mile.

128. To test the accuracy of the cadastral measurements, there have been 860 linear miles of check survey, of which 153 miles were measured by Assistant Surveyors and 707 miles by Native Inspectors; and for the topographical 4-inch survey, the Assistant Surveyors measured 35 miles of check survey.

129. The angular work was verified by 26 observations for azimuth which were taken by the Assistant Surveyors during their measurements of the main traverses; and the average error in this work was found to be 2 minutes per 100 angles. To verify the measurements recorded in the Cadastral Field Books, a certain number of triangles selected by the Assistants were plotted in office; these plots were then traced and compared with the original plans.

130. The village trijunctions have all been marked by stone pillars, about 1 foot square, embedded in masonry. In addition to these, specially-cut stones have been placed at the theodolite stations on the boundaries of villages, at an average number of 17 per village, or 7 per square mile. The minor bends of the boundaries in the Tarhawan Pargana of the Banda District are reported to have been marked in an exceptionally permanent manner by slabs of stone in place of the ordinary mounds of earth.

131. During the field season, lithographic transfer traces of 515 cadastral sheets of the Muttra and Banda Districts were prepared at an average cost of Rs. 4-2-8 per sheet, and forwarded to be lithographed at the North-West Provinces Government Press at Allahabad. Tracing in Colonel Anderson's office was stopped on the 1st April, as the publication of the sheets of the Muttra District had been completed, and as the Photographic Office in Calcutta could then undertake the publication of the remaining sheets of the Banda District.

132. During the past year, good progress has been made in clearing off the arrears of cadastral mapping. At the date of last Report (see paragraph 222), there were 2,327 sheets of previous seasons, remaining to be lodged; of these, 1,381 (which include the last sheets of the Muttra District) have been completed and forwarded, and 224 sheets are ready to be lodged after reductions for the general maps have been taken from them. There still remain, incomplete, in the office of this division, 722 sheets of previous seasons, and 589 sheets of the past season. Progress has also been made in bringing up the arrears of the drawing of the general maps on the 4-inch scale; all that remained of the Muttra District have been lodged, besides 50 maps of the Banda District. Of the general maps of Banda, there still remain 95 to be forwarded, which have been partially drawn.

133. The arrears of cadastral mapping are chiefly due, as previously reported, to the system which has been carried on in the Banda District (as well as in the other Districts of the North-Western Provinces, where the cadastral survey has proceeded simultaneously with the Settlement) of revising the survey maps and area statements to accord with Settlement investigations which have been made with the aid of preliminary tracings of the maps.

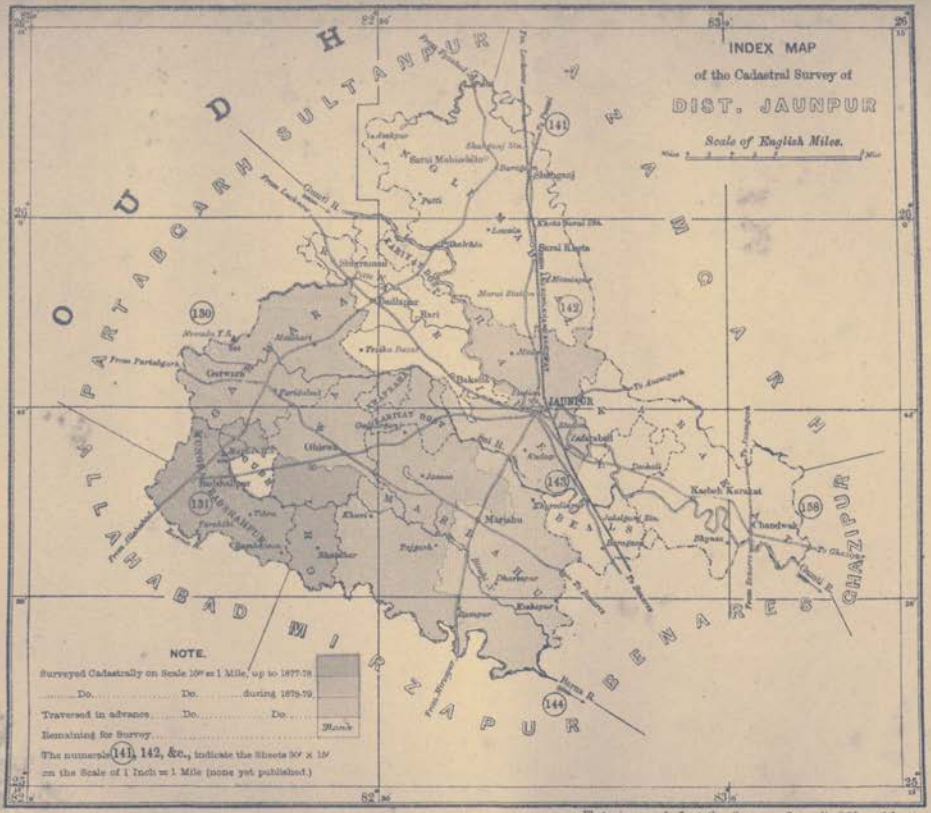
134. In the Agra and Hamirpur Districts, the revisions were carried out by a special party, whereby the offices of the 6th and 7th Divisions, which surveyed those Districts, were much relieved during the course of their subsequent operations; but the Surveyors of the 5th Division have carried out the revisions for themselves in both Muttra and Banda, which has added considerably to the work of the office, while a new season's work was still progressing.

135. Settlement investigations have been completed in Parganas Sihonda, Chhibu, and Badausa of Banda; the sheets and area statements of those parganas will therefore be revised during the ensuing six months. The records of Pargana Tarhawan cannot be taken in hand until the completion of the Settlement investigations now in progress.

136. The programme for Leveling operations in the Banda District has been completed during the year. The leveling has been restricted to the low-lying part of the District with the exception of one series, which has been taken to the base of the second range of hills. In all, 15 series have been measured during the season, at an average distance of 2½ miles apart, fixing 355 permanent bench marks, or on an average of one bench mark to every 2 square miles. During recess, the level data have been recorded on 56 4-inch sheets.

137. The total expenditure on leveling, including the fixing of 210 special marks, has been Rs. 2,567-15-1, payable by the Government of the North-Western Provinces, from Provincial Funds. The rate has been Rs. 6-5-11 per linear mile, which compares favourably with Rs. 8-5-5, the rate for last year. As no leveling is required by the Government of the North-Western Provinces, in the Mirzapur District, the leveling portion of the establishment will be absorbed into the professional party.

N. W. PROVINCES SURVEY.



Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B.R.E. F.R.S., *Surveyor General of India.*

Surveyor General's Office Calcutta.

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138. In the Banda District, there remain about 57 square miles of forest reserves for survey on the 4-inch scale, and about 6 square miles for cadastral survey on the 16-inch scale. In the Mirzapur District an area of about 400 square miles on the 16-inch scale will be surveyed cadastrally, and the traverse survey and triangulation will be extended over a further area of about 470 square miles.

139. The office of the 5th Division was inspected at Naini Tal during September. Great care was being taken to ensure accuracy in every step of the work, Colonel Anderson himself taking a large share in the duty of examination. It had been necessary to instruct some of the members of the establishment in the delineation of hills which was new to this party, and fair proficiency had been attained.*

XIX.—JAUNPUR DISTRICT (No. 6 REVENUE PARTY).

Personnel.

Mr. E. T. S. Johnson, Deputy Superintendent, 3rd grade, in charge.
Mr. E. C. Barrett, Assistant Superintendent, 2nd grade, transferred from 9th Division, Cuttack Irrigation Survey, on 1st December 1878, and retransferred to 4th Division, with effect from 1st July 1879.
Mr. P. A. G. Cowley, Surveyor, 3rd grade.
" J. H. O'Donel, Assistant Surveyor, 1st grade, transferred to Midnapur Revision Survey on 1st January, and retransferred to this Party on 21st March 1879.
" J. S. Swiney, Assistant Surveyor, 2nd grade.
" E. J. Martin, " " 3rd "
" A. W. Smart, " " 3rd "
" E. H. S. Gasper, " " 3rd "
and 27 Sub-Surveyors, &c.

Temporary Establishment.

236 Field Surveyors and others.

140. This establishment has continued throughout the year under the charge of Mr. E. T. S. Johnson. Recess quarters at Hazaribagh were quitted on the 15th October 1878. Field operations commenced in the Jaunpur District on the 23rd October, and were continued till the 15th April 1879. The survey was, as before, cadastral, on the 16-inch scale.

141. The season's out-turn, tabulated, is as follows:—

Parganas	Number of Villages.	Area in square miles.	Number of Fields.	Remarks.
Ghiswa	101	53·7	1,09,180	
Garwara	333	140·1	3,26,162	The average size of fields is 0·34 of an acre.
Mariahu, Karyat Dost, and Khapraha. . .	439	210·1	4,19,396	
Total . .	873	403·9	7,54,738	

In addition to the above, an area of 285 square miles of village boundary survey has been prepared in advance for the ensuing season. The cadastral survey has been carried on in the same manner as formerly; and the system has been continued, of recording all the field measurements in field books, which have been plotted to the scale of 64 inches=1 mile.

142. The Executive Officer regrets the doing away of the field books, and considers that "a good deal of bad work will pass which might otherwise be detected." He says, that "the plotted field books have been of great assistance in detecting errors in plotting, and in checking the boundaries of fields after the draftsmen have inked up the sheets." Also, "it is doubtful if every Field Surveyor will give in much more area than he did with the field book, for the plane-table sections are usually plotted by the Surveyors in leisure hours, *i. e.*, when not able to chain. Besides, when chaining, the Surveyors now plot their field books, which being rough are quickly done, whereas to plot the plane-table sections they must necessarily take more care and consequently will be a longer time about it."

143. Check surveys, as tests of the cadastral measurements, have been run through every sheet,—126 linear miles by the Assistant Surveyors and 1,282

* Colonel Anderson reports favourably on Messrs. Jackson, Campbell, Little, R. B. Smart, Freeman, and H'll

by Native Inspectors. Experienced Sub-Surveyors, who have been employed surveying the village sites and other topographical details, have also carried on an examination of the Field Surveyors' plans *in situ*. Only one station of the Great Trigonometrical Survey has been closed upon in the Jaunpur District, so that no triangulation distances are available with which the chain measurements of the traverses can be compared.

144. The demarcation of village boundaries was well in advance in Parganas Khapraha, Karyat Dost, and Mariahu, but was behindhand in Pargana Haveli Jaunpur. As the stones fixed at trijunctions are adopted as theodolite stations, the delay in the demarcation of Pargana Haveli, Jaunpur, necessitated the difficult operation of placing the stones in true position, in substitution of the temporary marks which had been put down in anticipation of the permanent demarcation. Baked clay cylinders have been placed at theodolite stations, one on either side of the trijunctions, as a supplementary demarcation in addition to the stones at the trijunctions.

145. Owing to the system described in paragraph 224 of last Report, under which Settlement investigations are deferred until after the publication of the maps, it is gratifying to report that the whole of the sheets of the season, 773 in number, except 10 kept back on account of unadjusted boundary disputes, have been sent to press, and at this date (1st January) but 18 remain to be printed. The expense of making preliminary tracings for the Settlement Department has thus been saved, and the office of the party has been cleared of any accumulation of the records of previous seasons, requiring revision, which under the former system greatly hampered current work. The general maps of season 1877-78 of the Jaunpur District had been prepared on the scale of 4 inches. These have now been replaced by 2-inch maps, which are to be submitted in future in conjunction with 16-inch cadastral surveys, and the sheets on this scale have been drawn as far as the cadastral survey has progressed.

146. During the coming season, endeavour will be made to complete the cadastral survey of an area of 550 square miles in Tahsils Jaunpur and Kerakut, and thus to complete those tahsils; it is also intended that the village boundary survey of the remaining portion of the district shall be completed. A new District will therefore be required for this party, so that the usual preparatory boundary survey may be carried on in advance during season 1880-81.

147. The office of this party has not been inspected during the year; but, Mr. Johnson, when attending the Survey Conference at Allahabad, brought with him some of the season's records, which showed the style of the survey to be good, and that the records were being carefully prepared. Credit is due to Mr. Johnson for the timely completion of the office work which has enabled the maps to be published before the commencement of another field season.*

XX.—BUDAUN AND GHAZIPUR DISTRICTS (No. 4 REVENUE PARTY).

148. This division, under charge of Major W. Barron, and having an establishment as per margin, left recess quarters at Naini Tal on 26th October, and proceeded to take the field in two sections—one section to complete the survey of certain village boundaries in the Budaun District, as well as to complete the Cadastral records of the Moradabad District,—and the second section to commence cadastral operations in the Ghazipur District.

Personnel.

Major W. Barron, Deputy Superintendent, in charge, on privilege leave for 3 months, from 4th August 1879.
Mr. E. C. Barrett, Assistant Superintendent, 2nd grade, transferred from 5th Division with effect from 1st July, in charge from 4th August 1879.
Captain A. J. C. Scott, Assistant Superintendent, officiating 2nd grade, on Medical Certificate furlough for two years, from 21st April 1879.
Mr. W. A. Wilson, Surveyor, 3rd grade.
„ H. T. Hanby, „ 4th „
„ S. O. Madras, Assistant „ 2nd „
„ W. J. Lincoln, „ „ 2nd „ transferred to Bengal, 14th November 1878, died at Calcutta, 16th December 1878.
„ W. D. Corbett, Assistant Surveyor, 3rd grade.
„ J. Murphy, „ „ 3rd „
„ L. F. Berkeley, „ „ 4th „
„ W. H. D. Ewing, „ „ 4th „
„ C. B. Taylor (Office Assistant) Leveler, and 31 surveyors, &c.

Temporary Establishment.

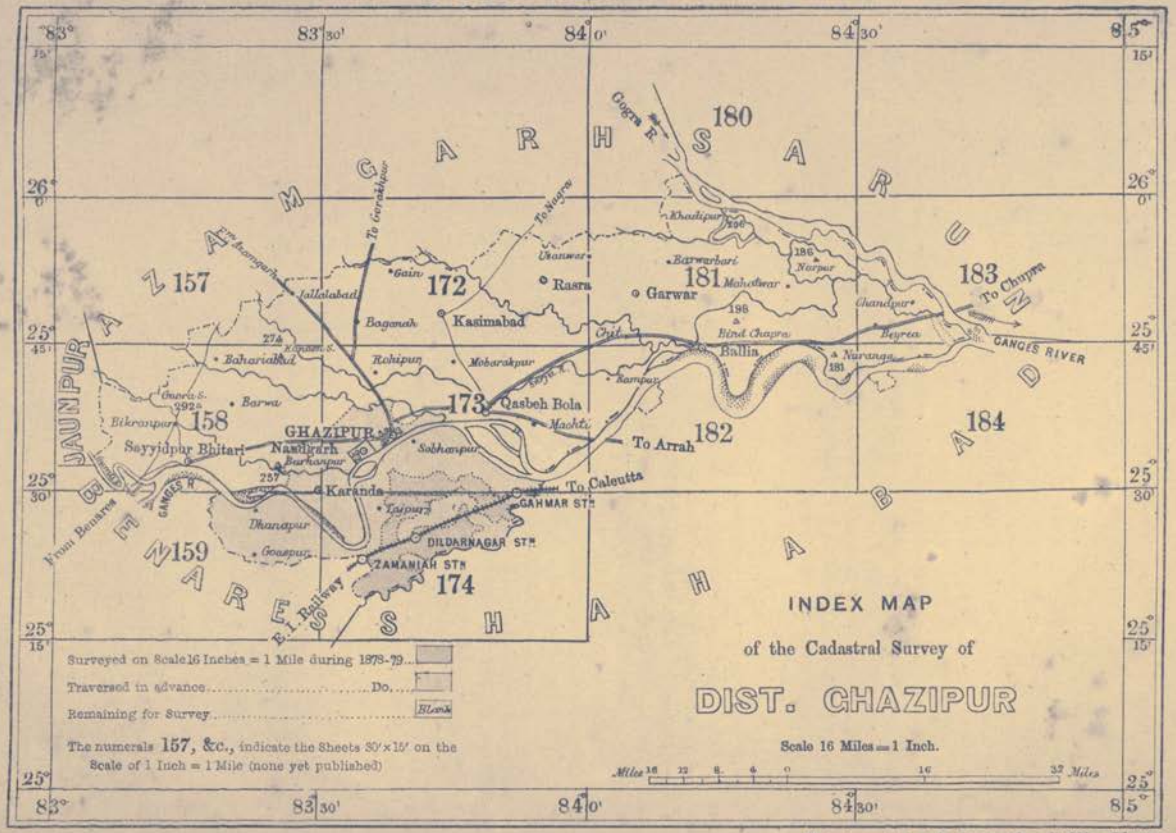
106 Field Surveyors and others.

149. The following changes in the establishment occurred during the year:—

Mr. W. J. Lincoln, Assistant Surveyor, 2nd grade, was transferred during November to a party under formation for British Burma; but he died in Calcutta on 16th December. Captain A. J. Corse-Scott, Assistant Superintendent, was first granted

* Mr. Johnson reports very favourably of Mr. E. C. Barrett, and commendably of Messrs. Cowley, O'Donel, Swiney, Martin, A. W. Smart, Gasper, and of all his Native Sub-Surveyors.

N. W. PROVINCES SURVEY.



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Surveyor General's Office Calcutta,

December 1879

privilege leave on account of impaired eye-sight from 7th October to 4th December; but not having obtained relief during this short rest, he was obliged to apply for longer leave, and on 21st April went on furlough to Europe for two years, on medical certificate. Major W. Barron was granted three months' privilege leave from 4th August, from which date the charge of the party was entrusted to Mr. E. C. Barrett, Assistant Superintendent, 2nd grade, who was transferred from the 6th Division for the purpose of relieving Major Barron.

150. In paragraphs 208 and 210 of last Report, the state of the arrears of the Moradabad records was reported, and it was then anticipated that the office work in connection with the arrears would be completed during January. The work, which included the preparation of tracings for lithography, indexing and inserting numbers in field books, correcting area books for changed fields, printing and examining the 4-inch reductions, and preparing statistical registers, extended into February, during which month the office establishment was transferred to add to the strength of the section of the party already at work in the Ghazipur District. The cadastral sheets of District Moradabad have now all been lithographed, and the original records have been lodged in Calcutta.

151. In District Budaun, the work has consisted of the completion of the village boundaries extending into the alluvial lands of the Ganges and Ramgunga Rivers up to the main stream. These boundaries had been left incomplete during the previous season on account of the uncertainty which existed as to the line to be adopted for the district boundary. A reference to the Government of the North-Western Provinces resulted in the issue of orders that the boundary between Budaun and Bareilly should be mid-stream of the main channel of the Ramgunga. The area of the Budaun District has been completed in accordance with this ruling; but it has since been ascertained on a comparison with the maps of the Bareilly District, surveyed in season 1870-71, showing this same boundary, that on account of the great changes in the Ramgunga River, certain portions of land have been twice included in the areas of different villages, while other portions have not been assigned to any village. It is now being considered, in consultation with the Board of Revenue, North-Western Provinces, how the village boundaries in the alluvial tract of the Ramgunga are to be recorded. All other work in connection with the survey of the Budaun District has been completed; the original maps for record in Calcutta and the copy maps for the office of the Collector are all ready.

152. Field work was commenced in the Ghazipur District on 5th November and was continued until 5th April. The out-turn has been 122·59 square miles of cadastral survey on the scale of 16 inches=1 mile, and 358 square miles of village boundary survey, prepared in advance for the cadastral survey of next season.

153. Observations for azimuth were taken at 60 stations of the main traverses, as checks on the angular measurements. As a test of the cadastral field measurements, check surveys amounting to 207 linear miles have been measured, about one-half of these being done by Assistant Surveyors and one-half by the Inspectors of cadastral measurements. The average area of the villages in Ghazipur is reported to be 356 acres, and the average size of the fields to be 0·54 of an acre.

154. The executive officer reports that in Parganas Zamania and Mahaitch the trijunctions of villages were found to be marked by large stones. In Parganas Karranda and Ghazipur, the demarcation had not been completed, but the stones will be fixed before the field surveyors commence operations; and for the future, arrangements have been made with the Collector that the demarcation will be completed before the boundary surveyors take the field.

155. The system of cadastral measurement has been that followed by all the Revenue Survey parties since cadastral surveying was undertaken by the Department. The Field Surveyors have been required to record all measurements in a field book, so that the village plan might be checked by the recorded measurements, or if necessary, be re-plotted on the original or any other scale. The chief advantage claimed for the field book is, that its preparation necessitates great care on the part of the Field Surveyor to provide extreme accuracy and completeness in his measurements, so that a map may be projected from the record if placed in the hands of an office draftsman. This plotting in office, either systematically of the whole of the cadastral measurements, or in part as

a test of the Surveyor's own plotting, has been one of the checks adopted in most of the cadastral survey offices to ensure a high standard of work from the Field Surveyors, and the system has been held in great esteem by officers of long survey experience. Another advantage provided by a field book is, that a record is obtained of the actual measures of the fields, and figures are thus available for the enlargement of the map if required. Besides, when the cadastral surveys were first introduced in the North-Western Provinces to take the place of the old Settlement surveys, the professional field book was required by the Civil authorities as a necessary substitute for the Settlement record of the lengths and breadths of the fields; and on this account the field book has hitherto been considered to be a Settlement as well as a professional record. While the advantages of the field book have thus been generally recognised, some officers of much experience have been led to consider that the practical utility of the record does not justify the labour and expense attendant on its preparation. No such record is required for topographical surveys on the 4-inch or other scales; and as check surveys are found to ensure careful work in the case of these operations, it was considered that the same checks might be accepted as a sufficient test of the accuracy of the cadastral measurements. The question was fully discussed at a Conference of Civil and Survey officers assembled at Allahabad in April last, when it was decided that the field book should not be prepared in future. The Civil officers declared that the record of measurements might be dispensed with for Settlement purposes, and the Survey officers were of opinion that the record was not necessary to ensure professional accuracy.

Another change in the description of one of the records required from the North-Western Provinces' cadastral surveys was agreed to at the Allahabad Conference. Hitherto the area columns in the vernacular *Khusra* forms have been filled up in the Survey offices, and the forms have been forwarded for completion in the Settlement offices. In future, an English "Area Book," a slight modification of a computation form already in use in the Survey offices, will be sent to the Settlement offices to be transliterated there, and for the entries to be made in the proper columns of the *Khusra*.

156. The general maps which have hitherto been prepared by Revenue Survey parties engaged on cadastral operations have been on the scale of 4-inches=1 mile, similar in character to the maps of the parties engaged on 4-inch surveys, and differing only in being reduced in office from the cadastral plans instead of being the result of original surveys. These maps, although involving great labour in their preparation, were seldom required for issue to the public; in a few Districts where irrigation works were in progress, or were being planned, they have been published on the requisition of the Irrigation Department; but as a rule, the maps were brought to Calcutta to be made use of only for further reduction and issue on the 1-inch scale. It has therefore been decided that 4-inch reductions are not to form part of the work of a party engaged on cadastral surveys on the 16-inch scale. The general maps prepared in the offices of these parties will in future be on the scale of 2 inches=1 mile; they will show village boundaries, and will be drawn in a style that will allow of their being sent to the Photographic Office for reduction to the scale of 1 inch=1 mile, without the necessity of a second drafting in Calcutta, as is the case when the general maps are submitted on the 4-inch scale.

157. The 2-inch maps of District Ghazipur have been commenced, and five sheets have been partially drawn. No further progress could be made, as the area surveyed did not fill the sheets, which are of the standard size.

158. In paragraph 224 of last Report it was stated that the examination of the cadastral maps by the Settlement Department previous to publication would not be carried out in the Ghazipur District. This change of procedure has acted most advantageously on the early publication of the maps; the sheets have been sent down to Calcutta during the recess, as the drawing and area computations could be completed; and the whole out-turn of the season has been published, and the photozincographs have been issued to the Settlement Officer.

159. One of the camp offices of the 4th Division was visited in the field in the Ghazipur District during April, and the recess office was inspected at Naini Tal during September. Major Barron's arrangements are all excellent, and the establishments, both in field and office, work most carefully under the

close supervision which he exercises. During Major Barron's temporary absence, Mr. Barrett, Assistant Superintendent, has carried on the executive duties most satisfactorily.*

XXI.—KHORDA GOVERNMENT ESTATE, DISTRICT POOREE (No. 7 REVENUE PARTY).

160. This party has remained throughout the year under the charge of Mr. R. B. Smart. The recess office was held at Cuttack, and the party moved into camp on the 15th December 1878 to resume field operations, which were continued up to the 15th June 1879. An important change in the procedure of the Khorda Survey has received the sanction of Government during the year (see letter No. 251, dated 9th June, from Secretary to Government of India, Revenue, Agriculture and Commerce Department, to Secretary to Government of Bengal) whereby the cadastral measurements of the fields hitherto done by the Survey Department will in future be relegated to the Settlement Department, but the work of the past season has not been affected by the change, which will only come into practice during the field season of 1879-80. The only difference has been that the traverse survey executed in advance will be utilized for cadastral measurements by the Settlement Department, and not by the Survey Department.

Personnel.

Mr. R. B. Smart, Deputy Superintendent, 2nd grade, in charge.
Mr. A. D. Smart, Surveyor, 3rd grade.
" C. David " 3rd "
" W. Vyall " 4th "
" H. Dowman " 4th "
" T. Dunne, Assistant Surveyor, 1st grade.
" G. Campbell, " " 3rd "
and 25 Sub-Surveyors, &c.

Temporary Establishment.

170 Field Surveyors and others.

161. The season's out-turn has been :—237⅛ square miles of cadastral survey on the scale of 32 inches=1 mile; 52 square miles of 4-inch topographical survey; and 177 square miles of village boundary survey, traversed in advance for the Settlement Department. The topographical survey, consists of an overlap surveyed beyond the Khorda boundary into adjoining Native States, and also of several portions of hilly country within the tract surveyed cadastrally, of which a survey on the scale of 32 inches is not required. Although the cadastral area surveyed is less than that of the previous year by 13 square miles, the number of fields has increased by 40,144; the average size of the fields being 0·27 acre, in place of 0·31 acre of last season. Sickness, due to the prevalence of fever on the borders of the Chilka lake and in the neighbouring country, is said to have materially retarded survey operations.

162. Seven sides of the triangulation of the Great Trigonometrical Survey have been available for check of the chain measurements. The average error of the chaining is in six cases, where plus, 2·84 feet per mile, and in one case where minus, 0·546 of a foot per mile.

163. As a check on the angular work, 29 observations for azimuths were taken. The cadastral measurements and topography have been verified by the measurement of check surveys, of which 134 linear miles were measured by Assistant Surveyors and 582 miles by Native Agency. Frequent inspections of the work of the Field Surveyors were also carried out as an additional check on the accuracy of their surveys.

164. The triple junctions of villages are marked by stone pillars 4 feet in length. They have been used as traverse stations, and the nearest traverse stations on either side have been marked with stones rather smaller in size; so that ample permanent marks have been provided for any future additions to the present survey and for the identification of the boundaries.

165. The work remaining for professional survey during the coming season is :—the topographical survey, on the 4-inch scale, of about 140 square miles of hilly country, situated on the western borders of the Estate; the topographical survey, also on the 4-inch scale, of several detached portions of hilly country, estimated to be about 50 square miles, within the tract for cadastral survey; and the village boundary survey of the scattered villages of Parganas

* Major Barron reports favourably of Captain A. J. Corse-Scott, who attended to his duties even when suffering acutely from impaired eyesight, which necessitated his going on furlough on medical certificate; he also commends Messrs. W. A. Wilson and Hanby.

Balbhadarpur and Tapang, which will be cadastrally surveyed by the Settlement Department.

166. Since the commencement of the survey of Khorda, 941 villages have been surveyed and mapped in 3,359 sections, of which, only 751 sections have been completed and sent to Calcutta ready for publication. The delay in completing the sections is chiefly due to the system at first adopted in Khorda, which required the retention of the maps until the discrepancies brought to notice by settlement examination could be adjusted according to survey remeasurement. To a great extent, this cause of delay has now been done away with, as the settlement alterations required in the maps are being introduced from measurements taken in the course of the settlement examination; a second visit of a Surveyor is thus avoided, and the maps will now be published in exact conformity with settlement requirements. The publication of the completed sheets has already commenced, and will be carried on partly by photozincography and partly by the ordinary process of lithography.

Of the 4-inch mapping, twenty sheets are completed and seventeen are in progress.

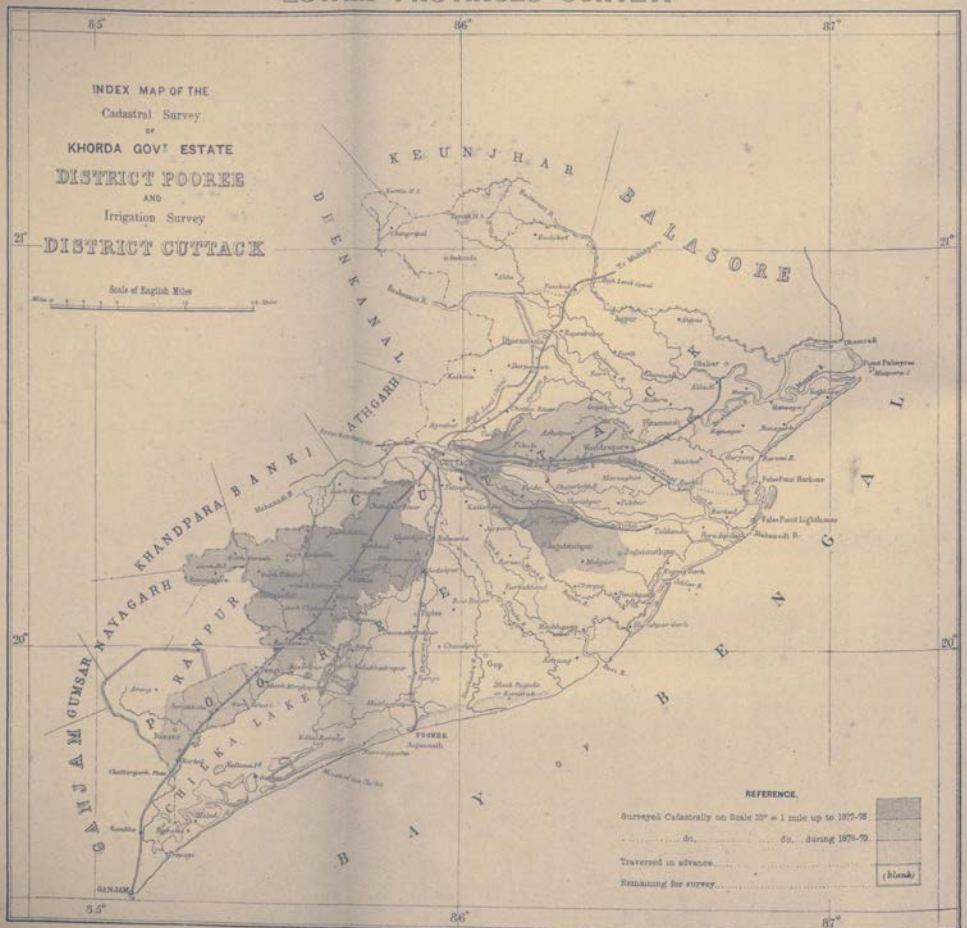
167. The recommendation for the change of procedure, which is about to be introduced for the remaining area of the Khorda Estate, originated with the Board of Revenue, who, on account of the strong objections taken by His Honour the Lieutenant-Governor of Bengal to the high cost of the operations of Survey and Settlement in Khorda, advocated a new system under which a large part of the work, hitherto performed by the professional party, would be undertaken by the Settlement Department. The system received the approval of His Honour the Lieutenant-Governor, and was communicated to the Surveyor General in letter No. 2948, dated 29th November 1878. It would have greatly disturbed the arrangements which had been made by the professional party for the continuance of the cadastral survey on the old system, had any change been introduced at that time of the year; the work of the past season has therefore been carried on the same as formerly, and the nature of the change in future procedure was not finally decided until the 11th February 1879, when a Meeting of Civil and Survey officers assembled at Cuttack for the purpose of taking into consideration the reorganization of existing arrangements.

168. The Meeting agreed to a change of system, decreeing even a larger transfer of duties to the Settlement Department than had at first been contemplated. It was decided, that for the remaining villages of the Khorda Estate, where a cadastral survey is required, the professional party will execute a traverse survey of the village boundaries, and prepare skeleton maps of villages and of sub-divisions of villages. These skeleton maps will be made over to the Settlement Department to enable them to carry out all the interior measurements required to define the limits of the fields, as well as the features of the topography in plain country. But should any hills fall within the villages to be cadastrally surveyed, the survey of these will be done by the professional party on the 4-inch scale.

169. The Settlement Department will prosecute the cadastral measurements on the same system followed in professional parties, and will adopt the same style for the drawing of the maps, the rough system ordinarily made use of for settlement surveys being entirely abandoned. It is therefore not to be anticipated that any saving can be effected by the mere transfer of the same duties from one department to another; but, as the Settlement Department will arrange to have the settlement investigations carried out by the same men who take the cadastral measurements, and to have the two operations done simultaneously, the cost of the settlement establishment, which has hitherto been kept up solely for settlement investigations and which has been following after the professional surveyors, ought to be entirely saved.

170. It was ascertained during the Meeting that the Settlement Department do not required a cadastral survey in a hilly tract of country on the south-western borders of the Khorda Estate, and that for this portion, a 4-inch survey, shewing village boundaries, will suffice. The survey of the hilly country (of which the area is doubtful on account of the uncertainty regarding a part of the Estate boundary) will be done by professional agency during next field season. The professional boundary survey of several detached villages also forms part of the programme drawn up by the Meeting for future

LOWER PROVINCES SURVEY.



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operations. It has therefore not been possible entirely to withdraw the professional party from Khorda, but the strength of the party has been greatly reduced, and the work of the small detachment which has been left will probably be completed about September 1880.

171. With regard to the general maps on the 4-inch scale of the portion of the Estate to be surveyed by the Settlement Department, it is intended that the topography should be taken from the settlement maps by the ordinary process of reduction by pentagraph. It is doubtful, however, when these maps can be completed, as the Settlement Department may not be able to finish all the cadastral measurements during next field season.*

XXII.—IRRIGATION TRACTS, CUTTACK DISTRICT (No. 9 REVENUE PARTY).

172. The operations of this party were reported on in paragraphs 267 to 278 of the past year's Report. Mr. E. C. Barrett continued in charge up to the 28th November, when he was relieved by Mr. H. B. Talbot. Field operations were resumed on the 15th December 1878.

Personnel.

Mr. H. B. Talbot, Assistant Superintendent, 1st grade, in charge from the 29th November 1878.
Mr. E. C. Barrett, Assistant Superintendent, 2nd grade, in charge up to 28th November 1878.
Mr. H. R. Littlewood, Surveyor, 3rd grade.
„ J. R. Scott, Assistant „ 2nd „
„ G. W. Jarbo, „ „ 2nd „ transferred from Western Dooars Tea Grant Survey from 9th June 1879.
„ G. L. R. Scott, Assistant Surveyor, 2nd grade, on furlough from 11th June 1879.
„ C. W. J. Ford, Assistant Surveyor, 3rd grade.
„ B. M. Wilson, „ „ 3rd „
„ H. R. Adels, „ „ 4th „ died on the 14th January 1879.
„ E. B. M. Drew, Assistant Surveyor, 4th grade, transferred from 5th Division from 1st January 1879,
and 20 Sub-Surveyors, &c.

Temporary Establishment.

183 Field Surveyors and others.

173. The survey has been undertaken for the Irrigation Branch of the Department of Public Works, to facilitate the collection of canal water rates; and the entire expense of the party has been defrayed by the Public Works Department. In conducting the survey no endeavour has been made to group together the rice plots so as to show the limits of the "fields" of the cultivators, and the rice plot, or "*Kiari*," has formed the unit of the survey; these *kiaris* are of so small a size,—the average area for this season being ·16 of an acre,—that it has been necessary to map the cadastral sheets on the scale of 32 inches=1 mile.

174. For the first two months of the field season, progress was slow, owing (1) to the rice crops not being cut; (2) to the sickness consequent on the wet state of the country; (3) to the difficulty experienced in getting the zemindars and cultivators to attend; (4) to the delay in clearing lines through thick bush and grass jungle. When the country dried, sickness disappeared and better progress was made; but the difficulty in obtaining the attendance of the villagers still continued, and it was found desirable to discontinue the register of the names of owners and cultivators, which, it was ascertained, could be more readily undertaken by the canal establishment employed in the collection of the water rates.

175. When field operations were commenced, it was intended that an area of about 230 square miles should have been surveyed during the season, which would have provided a balance between the work in the field and the work in office during a recess of ordinary duration. The proposed area was completed about the middle of May; there were still several weeks during which field operations could be continued; the field establishment were all on the spot, ready for work; and it seemed to be expedient that an endeavour should be made to survey the whole area, even with the prospect that it would be necessary to prolong the usual recess season. Mr. Talbot was, therefore, urged to continue his field operations, so as, if possible, to complete the remaining area during the year; and this he successfully accomplished by the 18th July. The monsoon rains set in on the 20th June, after which date field operations were carried on under many difficulties; and great credit is due to Mr. Talbot and to his establishment for the perseverance they displayed, which has resulted in saving the necessity of another field season.

176. The area completed is 307·6 square miles, containing 798 villages. Of this area, 296 square miles has been cadastrally surveyed on the 32-inch

* Mr. Smart reports favourably of Messrs. A. D. Smart, David, Vyall, Dowman, and Dunne, and of all his Native Sub-Surveyors.

scale, and the remaining 11·6 square miles topographically on the 4-inch scale, the latter being necessary to complete the topography up to a river which skirts the irrigable area. The number of fields surveyed is 1,174,747; the average size of the fields is 0·159 of an acre.

177. The field measurements have been verified by the survey of 716 linear miles of check survey; of these, 184 miles were surveyed by Assistant Surveyors, and 532 by Native Inspectors; thus an average of about $2\frac{1}{3}$ miles of check survey has been run through each square mile of ground. The angular work has been corrected and checked by 10 azimuth observations.

178. The season's out-turn has been mapped on 1,669 sheets, and these, as they are completed, are being forwarded to be lithographed in the office of the Secretary to the Government of Bengal, Public Works Department. Reductions from the cadastral sheets to the 4-inch scale are also under preparation; and these will form a series of general maps of the whole irrigable area.

179. A large portion of the establishment of this party, both European and Native, has already been transferred to a new party organized by Major D. C. Andrew for the cadastral survey of the Bassein District in British Burma; and the remaining portion will be available for transfer on the completion of the office records, which will probably be during March 1880. The transfer of part of the establishment has to some extent affected the early completion of the records; but delay was anticipated when the field season was extended beyond ordinary limits, and the computation work connected with the very large number of fields has proved unusually heavy.

180. The trijunction points of all villages have been permanently marked with cut stones 3 feet in length; and the theodolite stations to the right and left of the trijunctions have been further secured by means of smaller stones 2 feet in length.

181. When the Cuttack Irrigation Survey was sanctioned by the Government of India, the area for survey was then estimated to be 283 square miles, and a grant of money for the survey was given on this assumed area. The estimate of the area irrigable from the Cuttack canals was afterwards revised, and 472 square miles were required to be surveyed; but no addition was made to the original allotment of funds. When, therefore, on a review of the financial position of the survey being made by the Superintending Engineer in September 1878, it was ascertained that the increased area could not be surveyed for the sum originally allotted, a recommendation was made by that officer to the effect that the survey of a portion of the tract, 96·5 square miles in area, should be abandoned. This proposal has received the sanction of the Government of Bengal; therefore the total area which has been surveyed during two seasons, *viz.*, 375·4 square miles, represents the full demand of the Irrigation Department. Owing to the increase of area, the expense of the survey has been greater than the sum originally allotted for the work, but the total cost cannot yet be given, as office work is still progressing.*

XXIII.—CACHAR DISTRICT (No. 8 REVENUE PARTY).

182. The formation of a small party for Cachar was referred to in paragraph 264 of last Report. Major S. H. Cowan was deputed to raise the party. Such men of the late Western Soane Irrigation, Survey as were available were placed at his disposal, and transfers were made from other divisions to complete the party to the required strength. The professional portion of the establishment was collected together at Calcutta, started thence by steamer on the 22nd November, and commenced work in Cachar on the 14th December.

Personnel

Major S. H. Cowan, Assistant Superintendent, Offg. 1st grade, in charge

Mr. G. Rae, Surveyor, 3rd grade, transferred from the late 8th or Western Soane Irrigation Survey, from 1st December 1878.

Mr. T. Shaw, Assistant Surveyor, 2nd grade, transferred from the late 8th or Western Soane Irrigation Survey, from 1st November 1878, and was on deputation to Goalpara and Garo Hills Boundary Survey, from 1st March to 31st May 1879.

Mr. T. J. Campbell, Assistant Surveyor, 4th grade, transferred from the late 8th or Western Soane Irrigation Survey, from 1st November 1878, and 16 Sub-Surveyors, &c

* Mr. Talbot reports favourably of Messrs. Littlewood, Jarbo, Scott Ford, and Wilson, and says that his Native Surveyors have, as a whole, given satisfaction.

ASSAM PROVINCE SURVEY.

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183. The present survey operations in Cachar have become necessary on account of the resettlement of the district which is about to be made. Previous to the requisition for a professional survey party, the Assam Government had intended that the cadastral survey should be executed by a settlement establishment which had been employed on the settlement survey of the Jaintia District; and for this proposed settlement survey, it was at first considered necessary that the village boundaries, according to the professional survey of 1864 to 1868, should be upheld as a basis of operations; but it was ascertained that these old boundaries, which had not been permanently marked, could not be identified on the ground, and as the relaying could not be carried out by the settlement surveyors, hence originally arose the necessity for the services of a professional party. But if a professional party were to be employed in Cachar, it was considered advisable that the cadastral survey should also be carried out under professional supervision.

184. The views of the Assam Government as to the relaying of the old boundaries were modified shortly before the survey party took the field, and it was decided that a rigid adherence to these boundaries was only compulsory in cases where the proprietary right in the land had been alienated. Such cases included only a small number of grants held in fee-simple, or under 99 years' lease; so that this important alteration in settlement procedure at once rendered it necessary to change the constitution of the survey party, as instead of the party being employed during the first season solely in relaying old boundaries, as was expected, it was now required to make an immediate commencement in the cadastral measurements. The actual number of grants and *mouzahs*, of which the professional party was required to relay the boundaries during the season, was only seven.

185. As long as it remained doubtful whether the first season's work would be chiefly confined to the relaying of old boundaries, little could be done towards raising an establishment of cadastral surveyors, but it was known that a large number of Bengali *amins* of the late Jaintia Settlement Survey would be available on the spot, and it was thought probable that these men, who already knew how to survey with compass and chain, could easily be instructed in the professional system of cadastral surveying. The Bengali *amins*, however, would necessarily require instructors, who also would form a nucleus of the new establishment, and six men of the late Behar Irrigation Survey were taken to Cachar for this purpose. It had been intended that twenty should have been taken, but the Behar establishment had been dispersed previous to the formation of the Cachar party, and only six could be procured. The want of trained and energetic Surveyors from the North-Western Provinces was afterwards severely felt, as the attempt to train the Bengali *amins* was only partially successful. On this subject Major Cowan remarks as follows :—

"Before the *amins* could be set to work, it was necessary to teach them the cadastral system of surveying with chain only, with which none of them were acquainted. This was the most arduous undertaking of the season, as the Bengalis generally, while possessing good abilities, were disinclined to use their talents, except with the one object of getting pay for doing nothing; they hated the strict supervision of the Survey Department, and were continually longing for appointments in the demarcation establishment which preceded the survey. Much labour was lost over men who absconded, or who were found to have only pretended to learn, but before the end of February there were 38 fairly efficient *amins* at work."

Again Major Cowan writes :—

"The Bengali *amins* as a class, have hardly a good point, except that they write and draw neatly; but there is this in favour of their employment in preference to Hindustanis, that they know the language of the district, they can procure local measurers to serve under them (as the Cacharis will not do under Hindustanis), and they work in harmony with the inhabitants."

186. Although the settlement survey required the aid of a professional party to relay the boundaries of villages and tea grants, it was considered necessary to employ a settlement establishment, in advance of the cadastral survey, to relay and demarcate the boundaries of *mehals* (lands held under a *pottah* or lease) within the villages, regarding which boundaries, there was known to be much confusion and dispute. The *mehals* had not been mapped by the revenue survey of 1864-68; but settlement maps of 1842-43 were forthcoming, according to which, the boundaries of the *mehals*, if not subsequently altered by decree of a civil court, had to be adjusted in the case of

disputes. The boundaries disputed during the course of this preliminary settlement demarcation were very numerous; about 1,000 cases were taken into Court, and about twice that number are believed to have been compromised in the villages with the aid of the old settlement maps.

187. The cadastral survey adopted the boundaries of *mehals* which were fixed during this preliminary settlement investigation; and to ensure conformity with the settlement awards, maps of the boundaries by compass and chain were prepared during the investigations and made over for comparison with the maps of the cadastral survey.

188. Subordinate to the *mehals*, there are other sub-divisions of land which were recognised and separately mapped by the cadastral survey during the greater part of last season; these sub-divisions are the shares in the *mehal* held by each co-partner in a joint lease—a description of tenure which is almost universal in Cachar,—some *mehals* being met with having as many as 200 shares, but the more common have from 6 to 20.

189. Again, within the shares of the *mehal* there are the *kiaris* or rice terraces. These terraces at the commencement of the cadastral survey were made the unit of measurement; but when their average area was ascertained to be so small as ·03 acre, their separate survey was discontinued on account of the very high cost of such a minute survey, and the share of the co-partners in the joint leases became the unit. The average area of the shares was found to be ·85 acre. During the progress of the survey, some cases of disputes between co-partners in the same lease coming before the Settlement Officer caused him to doubt the expediency, and even the legality, of attempting to survey the boundaries of shares; the question was referred by him to the Chief Commissioner of Assam, with the result that orders were received on the 5th May to discontinue the survey of the shares. The effect of this change would have largely reduced the work of the survey by increasing the unit from ·85 acre to 3 acres, but the order came too late to have any appreciable effect on the out-turn of the season.

190. Under the exceptional circumstances attending this new survey, the out-turn has necessarily not been large; the area cadastrally surveyed is 39 square miles, and an additional area of 91 square miles of village boundary survey has been traversed in advance. The operations have been carried on in the western part of the Cachar District to the north of the Barak River. A pillar, built at Rampur, to mark the station of origin of the traverses of the survey by the late Mr. Davey in seasons 1864-68, has been identified, and has also been adopted as the station of origin for the new survey. The meridian lines of the two surveys having thus been made identical, has facilitated the restoration of the old boundaries, where these were required.

191. The survey, which has been mapped on the scale of 16 inches=1 mile, has been carried on by field book, and besides a field book of measurements, the field surveyors were required to prepare a register (*khusra*), recording the name of the co-partner, name of cultivator, class of land, and crop. These registers do not usually form part of the duty of a field surveyor, but it was urged by the Settlement Officer, if they were not prepared at the time of survey, it would be necessary for him to entertain a special establishment for the purpose to follow after the surveyors.

192. Azimuths were observed at 18 stations to check the angular work, and the average corrections required were 1 minute in 11 angles. Two Great Trigonometrical Survey stations were connected upon, the result showing an average error in the chain measurements of 4·8 feet per mile.

193. In addition to what has been already stated, Major Cowan brings forward the following as some of the difficulties he had to contend with:—

"1. The chief obstruction was undoubtedly the want of previously executed demarcation, which, in contravention of long established custom, necessitated the settlement and survey establishments being at work simultaneously on the same ground. Under the circumstances of the case, this could not have been avoided. The professional party was organized and sent to Cachar, primarily with the object of redemarcating boundaries for the settlement; but, as it turned out, the settlement had to demarcate boundaries for the survey.

"2. The tract under survey was, excepting along the Barak River, very sparsely inhabited, so that men were not available for line clearing through the jungle, and the progress of the boundary survey was thus very slow.

"3. Some of the sub-surveyors (7 in number) turned out unsatisfactorily,—one was dismissed for incompetency and another for misconduct. If a sub-surveyor was energetic and tried to push his way, he got into trouble with the inhabitants; if he were indolent, he got no help and his work did not progress.

"4. Much of the chaining was over a difficult country through grass and reed jungle, swamps, and abrupt hillocks.

"5. The difficulty of a strange language was felt throughout the season.

"6. The people of the country were passively obstructive, and of such indolent habits that they could often not be got to attend before noon, and never before 10 A.M."

194. Field operations were continued until the setting in of the rains, when, the country having rapidly become inundated, it was quite impossible to work any longer. On the 10th May, the field office was destroyed by a violent storm, and operations were finally closed on the 19th May. The office then went to Shillong, where recess duties were commenced on the 26th of the month.

195. The experience of the past season, as well as financial considerations, rendered it absolutely necessary that a new procedure should be adopted. From what has been reported of the various changes which were carried out as operations advanced, the requirements of the Settlement were finally ascertained to be, the definition of the *mehal* boundaries according to settlement investigation, to be followed by an accurate survey of the boundaries and details of the *mehals* on a professional basis, with a professional determination of areas. Several meetings were held at Shillong between Mr. S. O. B. Ridsdale, Secretary to the Chief Commissioner, Captain M. O. Boyd, Settlement Officer, and Major S. H. Cowan, Assistant Superintendent of Survey, to discuss the question as to how these objects could be most satisfactorily attained in the least expensive manner. After considerable discussion, it was at last determined that the professional basis of the village boundaries of the cadastral maps should still be continued through the agency of a small professional detachment, to be placed under the orders of the Settlement Officer; and that on the accurate framework provided by this detachment, the civil establishment of the Settlement Officer should project all the measurements by which the true boundaries of the *mehals* would be ascertained, as well as all cadastral measurements necessary for the mapping of the details of *mehal* lands. The future survey is in fact to be a settlement survey, but done in accordance with the Revenue Survey system; and the professional party, as a separate establishment under a senior officer of the Survey Department, will cease to exist. At the same time, by retaining a small professional detachment, provision is made for relaying any boundaries of the old survey of 1864-68 that may be required to be upheld in the present Settlement; and the professional detachment will also aid in the computation and check of the detail areas.

196. The proposal was agreed to by the Chief Commissioner of Assam, and has been sanctioned by the Government of India. The Professional Party has therefore been withdrawn, leaving a detachment of the strength noted in the margin under the orders of the Settlement Officer of Cachar.

Mr. W. H. Patterson, Surveyor, 1st grade, appointed on his return from special leave on 4th January 1880.
Mr. T. J. Campbell, Assistant Surveyor, 4th grade,
and 9 Sub-Surveyors, &c.

197. During the field season, an application was received from the Chief Commissioner of Assam for a Surveyor to be placed at his disposal for the purpose of restoring an old line of boundary between the Garo Hills District and District Goalpara, which had been abandoned as the boundary of the Districts, but the definition of which was necessary in order that certain *zemindari* rights might be upheld.

Mr. T. Shaw, Assistant Surveyor, was detached from the Cachar party for the above duty, and he commenced work, in communication with Captain Peet, Deputy Commissioner of the Garo Hills, near Dhubri, on the 21st March. Mr. Shaw encountered great difficulties in line clearing and in fixing points for determining the direction of the old line; both he and his establishment suffered much from sickness and from want of water; and on the 18th April, when 16 miles had been relayed, the whole party being prostrated by sickness, the work had to be discontinued for the season. About 90 miles still remain to be done, which will probably occupy Mr. Shaw, who will resume the work on 1st December, for four months during the ensuing season.

198. During the recess season, applications were received both from the Government of Bengal and from the Chief Commissioner of Assam for the

services of a Surveyor to assist the Collector of Rungpore and the Deputy Commissioner of Goalpara on the occasion of a revision of the common boundary between those Districts.

Mr. T. Shaw, Assistant Surveyor of the Cachar party, was again selected, and he was employed on this detached duty from 11th August to 11th September. His services are very favourably reported on by the Collector of Rungpore and the Deputy Commissioner of Goalpara, the officers with whom he was associated.*

XXIV.—LOHARDUGGA DISTRICT (BARKAGARH, PATTIA, AND SALEM ESTATES SURVEY).

199. The curtailment of the operations of this party was referred to in paragraph 286 of last Report. On Captain Sandeman's transfer to the charge of the British Burma party, Mr. J. Campbell was placed in charge, and on him has devolved the completion of the survey and the final submission of the records. The office work was brought to a close in August 1879, when the party was finally broken up, and its members transferred to Burma and elsewhere, as requirements necessitated.

Personnel.

Captain J. E. Sandeman, Deputy Superintendent, 3rd grade, in charge up to 10th December 1878.
Mr. J. Campbell, Assistant Superintendent, 1st grade, in charge from 11th December 1878.
Mr. D. A. King, Assistant Surveyor, 1st grade, transferred to British Burma Survey from 1st August 1879.
Mr G. E. Parker, Assistant Surveyor, 3rd grade, transferred to British Burma Survey from 1st December 1878,
and 7 Sub-Surveyors, &c.

Temporary Establishment.

29 Field Surveyors and others.

200. No attempt was made to commence field measurements till the close of December, as the establishment was more usefully employed in finishing up the arrears of office work of season 1877-78. There was also a difficulty in raising the establishment to field strength, as most of the field surveyors had been taken to Burma, and it was the end of January before others had been fully trained. Field operations were continued till the end of May, when the survey of the several estates was completed.

201. The area cadastrally surveyed during the year is as follows :—

	Square miles.
In Barkagarh Estate	7·6
„ Pattia „	24·2
„ Salem „	3·6
Total	35·4

Of this area 1·8 square miles were a revision of work surveyed in 1877-78. A village boundary survey of an additional area of 41 square miles, of which the details were not required to be mapped, was also executed. The work has been of a disconnected nature on account of the detached positions of the villages of the three estates. The detached villages have not been connected one with another by measured traverses, but their true positions have been established by means of connections on triangulation stations of the Chota Nagpore Topographical Survey.

202. The Barkagarh Estate contains an area of 138·7 square miles, included in 118 villages; of these, 78 villages have been surveyed cadastrally, and the field areas computed; of 10 "*zemindari*" (or permanent tenure) villages, the survey has also been cadastral, but the field areas have not been calculated, as they were not required for settlement purposes; the remaining 30 villages are "*zemindari*," and these have been surveyed in boundary only.

203. The Pattia estate has an area of 26·2 square miles, included in 12 villages, of which 10 have been surveyed cadastrally, and 2, being *zemindari* villages, have been surveyed in boundary only; 9 of the villages are scattered singly, and 3 lie together in one block.

204. The Salem Estate has an area of 5·6 square miles, included in 4 villages; of these, 1 village has been cadastrally surveyed, and the remaining 3 have been surveyed in boundary only.

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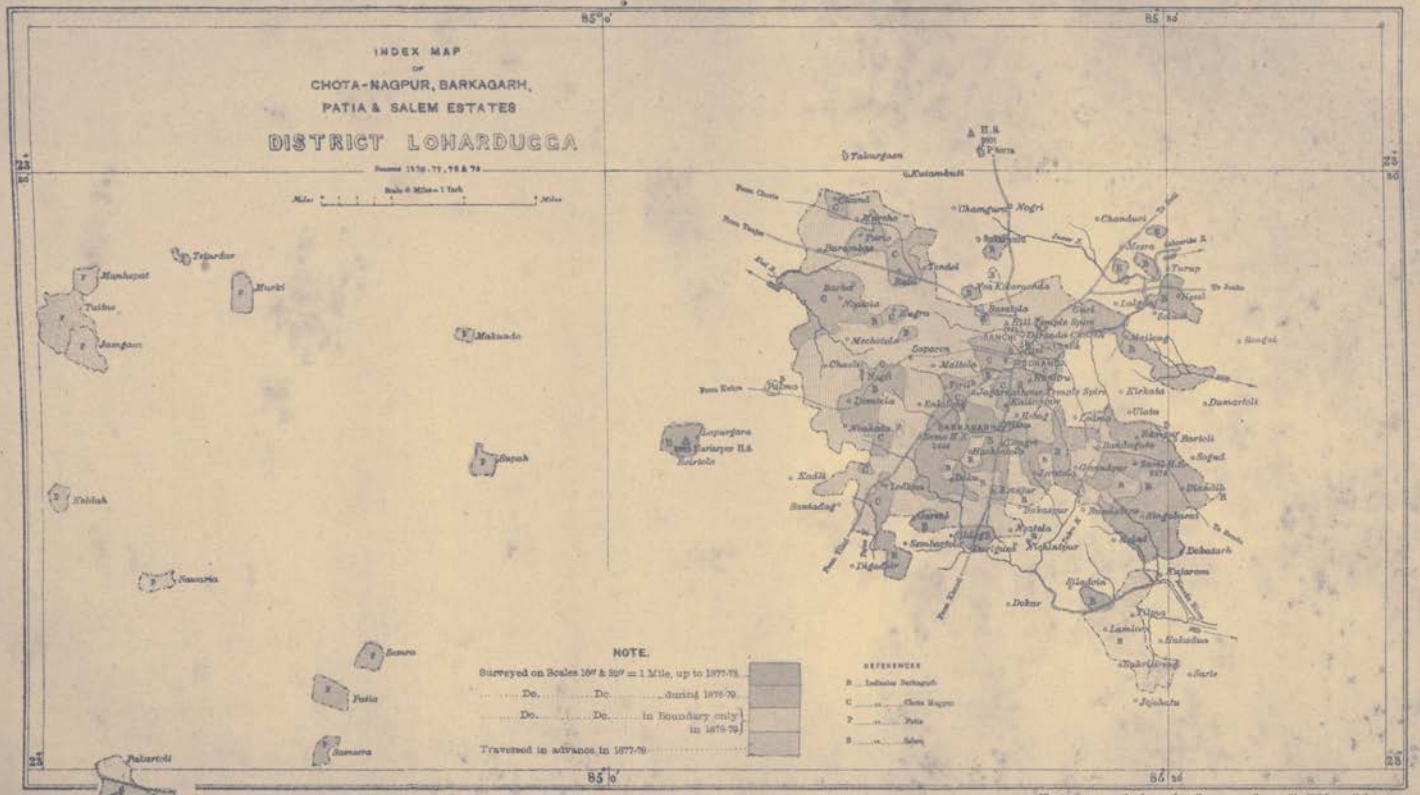
* Major Cowan reports very favourably of Mr. T. J. Campbell and of his native establishment generally.

LOWER PROVINCES SURVEY.



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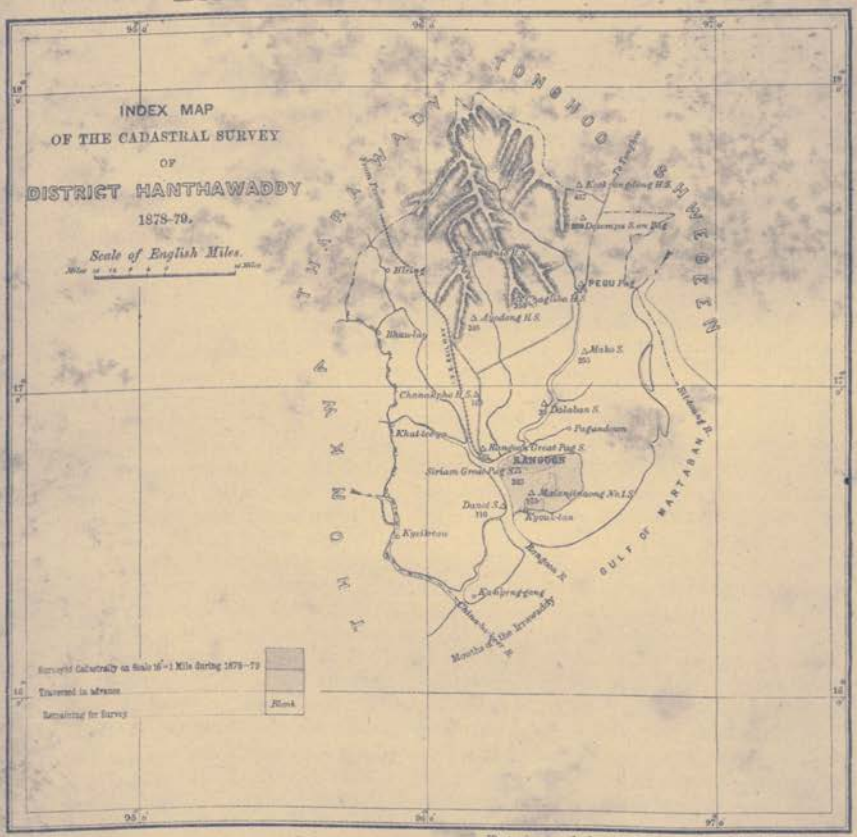
BRITISH BURMA SURVEY.



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205. The village boundary traverses have been connected with 8 hill stations of the Chota Nagpore Topographical Survey. The cadastral measurements were tested by 13 linear miles of check survey, and the angular work verified by 14 azimuth observations.

In paragraph 280, as well as in the extract published at page 128, of last Report, it was explained why the *kiari* or rice field had been made the unit of survey. When Mr. Campbell took the field in January 1879, the Settlement Officer, after consultation with the Deputy Commissioner, decided that a holding survey would satisfy his requirements; his wishes were accordingly attended to, and the *kiaris* have been omitted in the operations of the season.*

XXV.—HANTHAWADDY (LATE RANGOON) DISTRICT (BRITISH BURMA REVENUE PARTY).

206. The need for an accurate field survey of the Districts in the Pegu Division of British Burma had been felt for several years on account of the inaccuracies in the returns of the native land measurers, and a correspondence which had been continued since 1876 between the Chief Commissioner and the Government of India led to the final orders for the despatch from India of a cadastral party, which were conveyed in letter No. 599, dated 21st September 1878, from the Secretary to Government, Department of Revenue, Agriculture, and Commerce, to the Surveyor General.

207. Before deciding on the organization which might be best suited for the party to be employed in British Burma, it was considered desirable that an officer of the Survey Department should be deputed to visit Rangoon, to make enquiries as to the nature of the work to be done, to consult with the Chief Commissioner and district officers, and to draw up a programme of the manner in which the survey should be carried out. Major Sconce, then Deputy Superintendent, in charge of the Soane Irrigation Survey, was selected for this duty; and, with the sanction of the Government of India, he proceeded to Rangoon during the latter part of October 1878. On arrival, Major Sconce first directed his attention to have arrangements made for a tract of country to be prepared for survey by the permanent demarcation of the recognised divisions of the land. The divisions which were then selected for the unit of demarcation were the holdings of the cultivators, as these represented the limits of the rights of occupancy, and as they were the only divisions, the boundaries of which were fully recognised by the people. The existence of other larger divisions was also ascertained—the *Kwengs* (an appellation originally applied to a clearance of rice-growing land),—of which the boundaries were also recognised when conterminous with the boundaries of holdings, but for which, arbitrary boundaries would have to be determined where the country was still uncleared; and it was decided that the boundaries of these should also be demarcated, so that the *kweng* might constitute a division of land for local administration, and for survey purposes, similar to the *mouzah* of India. '*Teiks*," or Circles, are formed of groups of *kwengs* for convenience of collection of revenue; and Townships are administrative sub-divisions of Districts.

208. The next subject for inquiry was with regard to the division of land which should be adopted as the "unit of survey." The land of the lower districts of the Pegu Division, being almost exclusively devoted to growing rice, has been parcelled out into small plots surrounded by low banks for the purposes of rice cultivation; these small plots are the "fields" of British Burma, and groups of fields constitute the holdings of the cultivators; there were then the two divisions, the "field" and the "holding," one or other of which had to be selected as the "unit." The system of assessment hitherto in force has been to apply one rate, fixed separately for each *kweng*, on the total area of the holding, with deductions for such fields as might be fallow; the area, therefore, of most importance to the Settlement Officer was the area of the holding; although a record of the areas of the fields would be desirable, so that the deductions for fallow might be readily ascertained, and a map of the fields would be of value, so that in case of partition of holdings, the new boundaries might

* Mr. Campbell reports favourably of his only assistant, Mr. King.

be easily introduced, and the maps kept up as regards all changes of occupancy.

209. This important question of the unit of survey was discussed at a Meeting of Civil Officers assembled at Rangoon during Major Sconce's visit; the Meeting were unanimous in acknowledging the advantages of a survey by fields, but on its being represented by Major Sconce that the cost of a field survey would probably be double that of a holding survey, the holding of the cultivators was adopted as the unit of survey.

210. At the same Meeting, the demarcation as above described was approved, and the scale for the maps of the *kwengs* was fixed at 16 inches = 1 mile. It was also decided that, besides the holdings, the demarcation would be necessary of several other plots of land within the *kwengs;* these are, chiefly, the common grazing lands, the lands attached to fisheries, and the lands assigned for the sites of villages, regarding all of which, certain investigations would have to be carried out before the boundaries could be made final. On account of the enquiries to be conducted, the demarcation had necessarily to be done under the authority of Civil Officers. The Chief Commissioner therefore issued instructions to the Deputy Commissioner of Rangoon to make immediate arrangements for the demarcation in his District, so that a tract of country, about 100 square miles in area, might be ready for survey by the end of January 1879.

211. On Major Sconce's return to Calcutta, steps were taken to organize a small party, which for the first season it was decided should be kept at half strength. Captain J. E. Sandeman was placed in charge, and the party, consisting of the establishment noted in the margin, left Calcutta for Rangoon on the 4th January.

Personnel.

Captain J. E. Sandeman, Deputy Superintendent, 3rd grade.
Mr. J. S. Pemberton, Surveyor, 3rd grade, transferred from Deputy Surveyor General's Office from 1st January 1879, and re-transferred to Deputy Surveyor General's Office from 27th September 1879.
Mr. D. A. King, Assistant Surveyor, 1st grade, transferred from Barkagarh Estate Survey from 1st August 1879.
Mr. G. E. Parker, Assistant Surveyor, 3rd grade, transferred from Barkagarh Estate Survey from 1st December 1878,
and 10 Sub-Surveyors, &c.

Temporary establishment.

65 Field Surveyors and others.

212. The first difficulty that presented itself to Captain Sandeman on arrival at Rangoon was with regard to menials for the surveying parties; it had been confidently expected that a sufficient number of men would have been found willing to serve on Rs. 10 a month, but an offer of Rs. 12 did not induce any to take service, though at the first some men might have been engaged on Rs. 15. It was hoped that the difficulty had at last been settled when a large batch of immigrants from Madras, who were being supported by the local Government, were made over for employment, their pay being fixed at Rs. 10, in place of Rs. 7, which they were receiving for subsistence at the immigrant depôt. With these men a commencement was made on the 22nd January; they worked for a short time, but never willingly, and finally they deserted in a body, leaving the party greatly crippled. A few measurers were afterwards entertained in Burma, and some were obtained from India, but the party could never be made efficient in this respect; and from last year's experience, it was decided that, in future operations, arrangements must be made before the beginning of each season, for transporting all menials from India. Further experience during the season also showed that it would be necessary to obtain from India, not only the limited number of menials who are usually kept up with the Indian survey parties for the duties of chain and flagmen, but that the numbers would have to be largely increased to provide for the clearing of the survey lines, as no labour could be procured for this purpose from the villages in the Rangoon District, and labourers from Upper Burma who were employed on line clearing had to be paid at the high rate of one rupee per day.

213. At the commencement of cadastral operations, Captain Sandeman endeavoured to carry out the survey of the holdings, in accordance with the decision of the Rangoon Meeting, through the agency of the Hindustani *amins* whom he had taken with him from India. It was expected that the *amins* would be guided to the holdings by the demarcations at the trijunctions of the boundaries; and also that they could readily obtain the attendance of the cultivators to point out the minor bends of boundaries from trijunction to trijunction, as the Burman surveyors of the previous Provincial Revenue Survey had been able to do.

Neither of these expectations was realized. The demarcations had not made sufficient progress before the commencement of the survey, although that would have been immaterial, as far as the field work was concerned, if the *amins* could have secured the attendance of the cultivators; in this they failed, however, and by themselves they were powerless to distinguish, in a net-work of rice fields, which were the boundaries of the holdings. In this difficulty, Captain Sandeman obtained sanction, as a temporary measure, to the survey of all the fields, with the intention that the boundaries of the holdings should afterwards be introduced by the revenue authorities. The party has thus during the past season made a field survey of 22 *kwengs*, covering an area of 31 square miles.

214. But while carrying on a field survey with his Hindustani surveyors, Captain Sandeman was making arrangements for the entertainment and instruction of Burmans, through whose agency he expected to be able to have the boundaries of the holdings surveyed without the necessity of surveying all the fields. In this he was partially successful. Having secured the services of several men who had been employed on the survey of holding boundaries with the Provincial Settlement Survey, he abandoned the field survey, and through the agency of Burman surveyors surveyed an area of 157 square miles of holding survey. The work was done very rapidly, on account of the large size of some of the holdings, but on being tested it was found to be untrustworthy, more especially as regards the topography, and the whole of the holding survey will have to be resurveyed. Captain Sandeman reports on this subject as follows:—

"It is wonderful what a large amount of holding survey in a very short space of time the Burmans accomplished, but the work, which was to some extent an experiment with untrained agency, could not stand the severe test of a theodolite traverse run across it. It was found that minor heads of cultivation had been neglected; creeks, village sites, and topographical details generally, could not be relied upon, as these the Burman has for years been accustomed to sketch. Some of the work was radically bad, and all of it more or less out of position with respect to the stations of the check theodolite traverse run across it. I have therefore rejected the whole of this work, returning the year's out-turn only as the "field-by-field" survey which has been accomplished, and regarding the remainder as a boundary traverse survey done in advance for next season. But I hope the holding survey will yet, to a certain extent, be utilized, and that the increase of revenue to Government, even from rejected survey work, will amount to a large sum. The records are being got ready for the Deputy Commissioner to assess the year's revenue upon, as the holding maps are far superior to any such attempts as the usual annual measurements, to arrive at the true areas."

On the subject of increased areas for assessment purposes, Captain Sandeman further reports that a comparison has been made between the present survey areas and the revenue returns on which the assessment was based during the previous year in the four circles brought under survey, which has shown that the areas used for assessment were in defect about 27 per cent.

215. The total area of field survey is 19,843·6 acres (31·0 square miles), and the area of boundary traverse survey in advance for next season is 184·4 square miles. The tract surveyed embraces four circles of the Syriam Township, and is situated on the left bank of the Rangoon River.

For the "field-by-field" survey, the field book system was adopted, and the work was afterwards plotted independently in office. From the field survey the average size of the fields is found to be ·74 acre; and the holding survey shows that the cultivators' holdings, in the four circles which have been surveyed, have an average area of 33·84 acres. The average area of the *kwengs* is about 2 square miles (1,254 acres).

216. The check surveys show that the "field-by-field" survey done by the Hindustanis is good; but some work done by newly-trained Burmans had to be rejected. Check azimuths have been observed at 21 stations, showing that corrections were required in the angular work of the traverses of 1 minute in 24 angles. Connections with the Trigonometrical Survey have been made at four triangulation stations, and the direct distances between these have been made use of to correct the chain measurements of the traverses.

217. Tracings of the 16-inch maps of 22 *kwengs*, of which a field-by-field survey has been made, have been prepared for the use of the Settlement Officer; and after the settlement investigations have been completed, arrangements will be made for the publication of the maps by photozincography in Calcutta. The general maps, which will be on the scale of 2 inches=1 mile, have

not been commenced, on account of the small area which has been surveyed; they will be brought up during next recess.

218. A few selected stations of the survey traverses have been marked with burnt clay cylinders, which it is hoped may last several years; but the general question of the nature of the permanent marks to be placed at the survey traverse stations, or at the boundaries of *kwengs*, is still undecided.

219. The total area of the Hanthawaddy District is believed to be about 5,000 square miles, of which probably about 3,600 square miles will be surveyed on the scale of 16 inches, and it is intended that the remainder should be surveyed on the scale of 2 inches=1 mile.

220. With regard to the future employment of Burmans as field surveyors in place of Hindustanis,—a measure which is very desirable, both on account of the saving which will be effected in the expenditure on transport, as well as with the object of rendering the survey employés more acceptable to the people of the country,—Captain Sandeman reports as follows:—

"Some of the "field-by-field" survey done by the Burmans had to be rejected. The experience of the past season has shown the good points as well as the defects in the Burman character. He is, as a rule, well educated and quick in understanding the use of surveying instruments, neat-handed, and very fond of the work, and when trained properly, will make a good surveyor. But the Burman has faults: he is conceited and difficult to break off habits he has acquired; they are a very cheerful and pleasant people to deal with, but very fond of amusement and hard to keep steadily at work. They are great adepts at "fudging," as was exemplified several times last season.

"The Hindustani surveyor having been found to be very much out of place in Burma, and last year's experience having also proved that the untrained Burman is most unreliable, I decided to train Burmans during the recess. By sending a circular to all district officers to say that only men who had gone through a course of training would be entertained, and by advertising in the local papers, men came from Henzadah, Prome, Bassein, and other districts, and for three months over 100 men have been in training; but the excessive rainfall has sadly interfered with much progress. Out of the men that have been thus partially trained I hope to form a camp of 60 field surveyors, * * * * * and after this season I trust I may be able to dispense with the Hindustani element, except in the case of those men who may choose to come across, paying their own way."

221. Towards the end of the field season, the Chief Commissioner was led to reconsider the question whether the cadastral survey in British Burma should be by holdings or by fields; the disadvantages of the limited amount of information afforded by a holding survey had prominently presented themselves, and the difficulties had become known that would be met with in the continuance of such a survey; at the same time, the great benefits of a survey by fields had also been more fully ascertained, and the experience gained during the first short season of survey operations seemed to justify the belief that the additional expense of a field survey would not be excessive.

On the 4th June 1879, Mr. D. M. Smeaton, Settlement Secretary, who had been recently transferred from Settlement duty in the North-Western Provinces, addressed a letter (Revenue Department No. 20-6) to the Secretary to the Government of India, fully setting forth the above briefly described views of the Chief Commissioner on the merits of the two descriptions of survey, and strongly urging that the survey by fields should be adopted.

222. The Government of India agree with the views entertained by the Chief Commissioner, that a survey by fields would in many ways be preferable to a survey by holdings; but before sanctioning the final adoption of the former system for British Burma, have resolved to await the results of the operations of the coming season in the Rangoon and Bassein Districts, for both of which the cadastral survey of 1879-80 is to be effected by fields (see Government of India, Home, Revenue, and Agricultural Department letters, No. 364, to the Chief Commissioner, and No. 366, to the Surveyor General, both of 12th August).

223. The Chief Commissioner has decided that it will be unnecessary for any permanent marks to be erected to define the limits of holdings, should the survey by fields be finally adopted, as it is considered that the banks of the rice fields are of themselves sufficiently permanent to do away with the necessity for any other marks. The boundaries of *kwengs* will be permanently demarcated, but the description of marks to be used has not yet been determined. To provide for this permanent demarcation, as well as otherwise to facilitate

the operations of Survey and Settlement in British Burma, a Bill has recently been introduced before the Legislative Council of His Excellency the Viceroy.

224. Captain Sandeman reports :—

"I am grateful to Captain Parrott, the Assistant Commissioner in charge of the Syriam Township, and to all the local officers for their cordial co-operation." *

MISCELLANEOUS.

XXVI.—KAMRUP DISTRICT (LAKHIRAJ SURVEY, REVENUE BRANCH).

225. This party, which had been brought down to Calcutta for the recess of 1878, left for Assam under charge of Mr. W. H. Patterson, on the 13th November, having been strengthened by additions referred to in paragraph 316 of last Report, and reached Gauhati on the 21st November. Field measurements were commenced on the 23rd November and continued till the end of May 1879. The party then proceeded to recess at Shillong, as it had been arranged that charge could be held by Major Cowan of the Cachar Party, in addition to his other duties, during the absence of Mr. W. H. Patterson on six months' leave. The recess office was opened at Shillong on the 10th June, and Major Cowan received charge on the 19th June 1879.

Personnel.

Major S. H. Cowan, Assistant Superintendent, 2nd grade, in charge from 19th June 1879
Mr. W. H. Patterson, Surveyor, 1st grade, in charge up to the 18th June 1879.
Mr. C. S. Kraal, Assistant Surveyor, 4th grade, joined 1st November 1878.
and 20 Sub-Surveyors, &c.

226. The procedure of this survey party was fully described in paragraph 310 of last Report, but the objects of the survey may be briefly described, as being to adjust the areas, and consolidate into compact blocks, the rent-free and half-rent-free estates (*lakhiraj* and *nisfi-khiraj*) that are held in small plots scattered throughout different villages.

227. The preliminary survey on the 8-inch scale extended to 457 plots, belonging to 312 estates, with an area of 43,748 acres. The final demarcation and boundary survey, after consolidation and adjustment of area, were completed of 253 plots belonging to 195 estates, area 21,651 acres, of which the preliminary survey had been done during previous seasons. These 195 estates, which are now included in 253 plots, had originally been held in 911 plots. The boundary of "Baghmara Chur" was also surveyed; the *chur* had been estimated to comprise an area of 5 square miles, but by survey it was found to be 28 square miles.

228. Special attention has been paid to the erection of permanent marks on the boundaries; and during the past season, 1,471 stones and 39 wooden posts have been placed. The outlay on this demarcation has fallen on the *lakhirajdars*, and in addition to the stones and posts, these men have of themselves erected 247 earthen mounds.

229. The following causes of delay are reported :—

(1) During the field season cholera was prevalent, but specially so during November and December, when one Sub-Surveyor and several measurers died; this scourge caused delay, as it necessitated the field squads being continually moved from one locality to another.

(2) The *mouzadars* and *lakhirajdars* were very dilatory in their attendance for the rectification of boundaries, and in supplying the necessary labour for clearing survey lines through their estates.

(3) Serious delay was caused by one of the survey elephants which broke loose on the 6th February, and in spite of every endeavour having been made to secure him, remained at large till the 4th March, when he died, apparently from excitement and exhaustion; during this period he continued in the neighbourhood of the survey camp, and made nightly attacks, destroying the camp tents and huts, and causing great alarm.

(4) During April the work was greatly impeded by floods, which eventually caused field measurements to be discontinued sooner than had been intended.

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* Captain Sandeman reports as follows on his assistants :—
Mr. J. S. Pemberton worked hard and well until he was invalided in June.
Mr. D. A. King has worked most zealously since joining in August.
Mr. G. E. Parker had a laborious task in surveying the main traverse, which he accomplished satisfactorily, and he has worked well in office.
Sub-Surveyors Oolean Shareef, Doorgid, Karim Ali, and Hilaludin deserve special mention for their good services.

230. Final plans, on the scale of 8 inches=1 mile, of 253 plots, of which the boundaries have been adjusted, have been prepared for record in the office of the Deputy Commissioner of Kamrup, and copies of these plans have been made for the *lakhirajdars*. The boundaries of the finally adjusted estates have been entered on the 4-inch maps of the District in the Deputy Commissioner's Office at Gauhati, and also on the series of 4-inch maps in the Calcutta Office.

231. Up to date, the area finally adjusted and demarcated in District Kamrup is 46,161 acres. The remaining area, understood to be 157,385 acres, is to be completed by a civil establishment under the orders of the Deputy Commissioner; consequently this establishment has been broken up, and the members have been transferred to other parties.

232. The reasons why the professional party is no longer required are given in the *Assam Gazette* of 26th July 1879, page 479.

One object of the survey being the consolidation of estates, by giving to a *lakhirajdar* one block of land, agreeing with the area to which he was entitled, in exchange for several scattered pieces; the resolution of the Chief Commissioner on this point is as follows:—

"In carrying out this system of consolidation, it was from the first assumed that the ryots on the Government lands thus given in exchange to the lakhirajdars would retain the same rights of tenure which they enjoyed as tenants of Government. The civil court, however, having held when the point has been raised in suits between the parties that the ryot in such cases loses all his right of occupancy, the Chief Commissioner has directed the discontinuance of such transfers except with the clear consent of the ryot.

"The Chief Commissioner is strongly of opinion that the essential part of the work remaining—the ascertainment of the actual area in possession of these *nisfi khiraj* and lakhirajdars, and the mapping of the holdings—could be done quite as effectually for all practical purposes by *ordinary amins* under the supervision of the Extra Assistant Commissioner, who has throughout had charge of the work, and that the professional survey may be altogether discontinued."

233. The above Resolution having met with approval and sanction of the Government of India, the Lakhiraj Survey by a professional party will cease.*

XXVII.—DARJEELING SURVEY (SPECIAL SURVEY OPERATIONS IN AND AROUND DARJEELING).

234. On completion of the field work of season 1877-78 in Northern Assam, this party was transferred to the Darjeeling District, with the object, *first*, of completing certain special surveys which were urgently wanted by the Bengal Government, *viz.*,—(1) A survey of Darjeeling station on a large scale: the boundaries of all locations to be ascertained and demarcated by permanent marks. (2) A survey of Hope Town lots, the boundaries to be similarly ascertained and demarcated. (3) A boundary survey of the Government khas lands, including the settlement of disputes where these exist between the Government and the owners of neighbouring grants: the boundaries to be afterwards permanently marked. (4) A similar boundary survey and demarcation of the forest reserves, especially with reference to disputed points. (5) A survey of the lands on the east of the Tiesta, available for native cultivation or tea. (6) A re-adjustment of Mr. Johnson's survey of the Terai, involving correction and demarcation of boundaries in accordance with the results of the present settlement.

Personnel.

Lieutenant H. J. Harman, R.E., Officiating Assistant Superintendent, 2nd grade.
Mr. W. O'Sullivan, Surveyor, 4th grade.
„ W Robert, Assistant Surveyor, 2nd grade.
„ D. J. Collins, „ „ 4th grade.
Mohibulla Khan, Sub-Surveyor.
Bhowani Din, „
and 4 others.

On the completion of this work, the party was to undertake a geographical survey of Independent Sikkim.

235. On the 12th May 1878, Lieutenant Harman arrived at Darjeeling and immediately placed himself in communication with the Secretariat and the local

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Major Cowan reports as follows on the services of the establishment:—

Mr. Patterson "made over charge to me on the 19th June. I found all the records in excellent order and the establishment thoroughly efficient, evidencing most careful and intelligent supervision on his part."

Mr. Kraal "was prevented by ill health from doing a full share of field work, but exerted himself most favourably during recess."

Native Establishment. Baboos Redoy Chunder Dass and Rupeshwur Surmah "have worked particularly well." Nasir Ali, draftsman, and Wazeer Ali, Sub-Surveyor, "have, as usual, done good work."

authorities with a view to ascertain precisely the nature and scales of survey necessary to meet the requirements of the Bengal Government, and further by personal investigation to learn how far the records of past surveys could be utilized. All this was satisfactorily accomplished, in addition to the ordinary recess work of the party, before the commencement of the field season in November.

236. The final decision arrived at, as regards the operations in the Darjeeling District, was that—

(1) A survey *de novo* should be made of the station of Darjeeling, exterior to the bazar and cantonments, on the scale of 20 inches to the mile, and of the bazar, on scales of 40 and 64 inches to the mile, embracing altogether an area of 2,240 acres.

(2) A complete survey of the Hope Town estates, 6,080 acres, on a scale of 8 inches to the mile.

(3) Definition of khas (Government) lands, 20,000 acres, and placing boundary pillars, scale 8 inches=1 mile.

(4) Mapping of grants of land applied for, east of the Tiesta River, for tea cultivation.

(5) Large scale revenue survey of the land east of the Tiesta River, reserved for native cultivation.

(6) Testing, re-adjustment, and demarcation of lands in the Terai, settled by the Deputy Collector, and compilation of a new map of the same on the basis of the previous survey by Mr. Johnson. To aid in defining boundaries and to settle disputes in connection therewith, the Government of Bengal deputed Mr. A. W. Paul, Assistant Commissioner, who was vested with the powers of a Collector under Act V. of 1875.

237. During November the whole establishment, European and Native, were under training for the special work which was new to them, and from this time to 1st June 1879, the work, as above described, which was scattered over nearly all parts of the Darjeeling District, was vigorously prosecuted by Lieutenant Harman and his assistants, the total out-turn as described by him being—

Triangulation in the Darjeeling District; 65 stations built and fixed in the hills and plains; 82 points fixed; heights obtained to nearly all the above.

Theodolite traverses in the hills and plains, 360½ miles; prismatic compass traverses, 120 miles; straight line boundaries cut in hills and plains and through some heavy forest, 56½ miles.

Detail Survey.

In Darjeeling Station, 28 acres on scale 60″ = 1 mile.
„ „ 50 „ „ 40″ = 1 „
„ „ 85 „ „ 20″ = 1 „

Hope Town estates in the hills, 9 square miles, on scale 4 inches=1 mile.

Daling Duars, tea land lots, 5 square miles, on scale 4 inches=1 mile.

Rhenock to the Jelep Pass, adjoining the road, 180 square miles, on scale 4 inches=1 mile.

Spirit leveling along the roads of Darjeeling, 15 miles.

238. Besides the above, a very large amount of work connected with boundary disputes, rectification of erroneous boundaries, and definition of new boundaries for the local authorities and Forest Department, was completed, the details of which are far too numerous to be given.

239. Nearly all the traverse and boundary work necessitated line-cutting in dense forest, and the marking and rectification of boundaries proved to be a very tedious and laborious undertaking, needing great patience and care on the part of the surveyors.

240. The work remaining to be done during the ensuing season is as follows:—

Completion of details in Darjeeling station, the bazar, and within municipal limits, on scales 20 inches, 40 inches, 64 inches to the mile, together with some boundaries and 3 miles of spirit leveling.

The survey of the "Sittong" plantation, on scale 8 inches to the mile. Demarcation of boundaries and erection of permanent marks for the Forest Department.

Rectification of boundaries and congregation of the settlement survey results in the Terai lands west of the Tiesta River; determination of the relative

position of isolated plots of cultivation in the hills of the Daling Kote Subdivision.

241. A geographical survey of Independent Sikkim will also be undertaken, as it can be accomplished during the ensuing season *pari passu* with, and without any detriment to, the operations in the Darjeeling District. Lieutenant Harman expects that, while it is in progress, much geographical information of the States adjoining may be obtained from the survey stations without actually crossing the frontier.*

GEOGRAPHICAL.

XXVIII.—GEOGRAPHICAL OPERATIONS IN AFGHANISTAN.

242. The extension of our geographical knowledge of Afghanistan, and the rectifications of the hurried surveys which had been made during the first Afghan war, but had never been properly combined together, have long been desiderata of great importance. So long, however, as it was the policy of the Government to prevent any attempt being made to survey regions beyond the British frontier, and even to discourage Survey Officers from pushing their operations up to the frontier, in order to avoid any risk of collision with the independent tribes beyond, it was impossible for the Survey Officers to do more than fix all the most prominent points on the hill ranges beyond, which were visible from the trigonometrical stations within the frontier, and to fill up the details of the country from native information, or by the secret agency of native explorers. In the summer of 1878 there was reason to expect that the time-honoured policy of "masterly inactivity" would shortly be departed from, and that the frontier line was no longer to be regarded as an impassable barrier to geographical research. Arrangements were being made for a force to proceed, under General Roberts, into the hill country between Quetta and Dera Ghazi Khan; and Captain Woodthorpe was to have been attached to the staff of General Roberts, with a view to making the most of any opportunities which might arise for survey operations, at any point along the entire length of the frontier line between the British territories and Afghanistan.

243. These arrangements had soon, however, to be changed into others for a more general and extended survey, which became possible when war was declared with the Amir of Afghanistan, and his kingdom was invaded at several points by our armies. A Survey Officer was then attached to each of the four columns which were formed, two to operate in Southern and two in Northern Afghanistan; but in a short time it was found necessary to treble the number of these officers, in order to meet demands from the Military and Foreign Departments and from the Commander-in-Chief, for a further extension of the survey operations.

244. It will be convenient to divide the operations into the three following groups, for description, *viz.*, 1st, those in Southern Afghanistan, with the columns under the command of Generals Stewart and Roberts; 2nd, those in the Kuram Valley, and generally to the south of the Safed Koh Range, with the column under General Roberts; and 3rd, those in the Kabul Valley, and generally to the north of the Safed Koh Range, with the column under General Sir S. Browne.

I.—THE OPERATIONS IN SOUTHERN AFGHANISTAN.

245. In October 1878, Captain Rogers was posted to General Biddulph's column which had been ordered to be formed at Quetta, and Captain Beavan to General Stewart's column which was being formed at Mooltan. It was expected that the Mooltan column would advance on Quetta by the direct, but as yet untried and unsurveyed, route crossing the Sulimani Range; while the portion of General Biddulph's column which was being sent from India would march on Quetta by the route *via* Dera-Bugti and Lehri, on the frontier between Upper Sind

Personnel.

Major (now Lieutenant-Colonel) W. M. Campbell, R.E., Deputy Superintendent, 2nd grade.
Captain W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade.
Captain T. H. Holdich, R.E., Assistant Superintendent, 1st grade.
Captain M. W. Rogers, R.E., Assistant Superintendent, 1st grade.
Captain R. Beavan, S.C., Assistant Superintendent, 2nd grade.
Lieutenant St. G. C. Gore, R.E., Assistant Superintendent, 3rd grade.
Lieutenant J. R. Hobday, S.C., Assistant Superintendent, 3rd grade.

* Lieutenant Harman reports favourably of the work performed by Mr. W. O'Sullivan, Surveyor; Mr. W. Robert Assistant Surveyor; and Baboo Dwarkanath Mukerji, Sub-Surveyor.

AFGHANISTAN
BALUCHISTAN
BRITISH DOMINIONS
MAP
SURVEY OPERATIONS
AFGHAN CAMPAIGN OF 1878-79.

and Beluchistan, to the entrance to the Bolan Pass. Captain Rogers being much delayed and hindered on his way to join the army, Captain Beavan, who had a shorter distance to travel, arrived first and joined General Biddulph's column. Captain Rogers accompained the Mooltan column, which had eventually to be marched on Quetta by the circuitous but well-known route *viâ* Sukkur and Jacobabad. Captain Heaviside, who was then returning from furlough, and Captain Holdich and Lieutenant Hobday, who were in England, were ordered by telegram to proceed to Quetta without delay: the former arrived there on the 8th January and the two latter on the 18th February. Lieutenant Gore was transferred from the Guzerat Survey on the 3rd January and reached Quetta on 13th February. Finally, Major Campbell, who had arrived at Bombay on his return from furlough to Europe and Australia on the 5th February, was also sent to Quetta, where he arrived on the 20th March.

246. Each of these officers was provided with as complete an outfit of instruments as the sudden demand admitted of, to enable him to execute any work that might be required of him, in the shape of route surveying, sketching with the plane-table, triangulation, or astronomical observation. A few native surveyors were attached to the force, and each officer had authority to entertain as many men as might be required to carry his instruments and render any other necessary services, engaging them on the spot or getting them from India, as might be most feasible.

247. Captain Beavan carried route surveys from a trigonometrical station on the frontier near Kusmore, along the Dera Bugti road as far as Lehri, from the foot of the Bolan Pass to within a short distance of Quetta, and from Quetta to Kandahar *viâ* Gulistan Karez, the Khojak Pass, and Chaman. He then accompanied General Biddulph's force to Girishk, surveying the line of road and also as much of the country around Girishk as his opportunities allowed. On returning to Kandahar, he was employed with other officers in making a survey of the country around Kandahar, within a radius of twelve miles, on the scale of 1 inch to the mile. In August he was employed in attempting to extend his route survey between Kandahar and Chaman into the country on either side, but was prevented from doing much by the very unfavourable condition of the atmosphere and by ill-health. He was subsequently sent to Sibi, where he is still employed.

248. Captain Rogers carried a route survey from Quetta to Kandahar *viâ* Gulistan Karez and the Gwaja Pass through the Khwaja Amran range. While General Stewart's column was halting in Pishin, he ascended the highest peaks of the range with a theodolite, and took observations to a number of points on the northern side of the range and towards Kandahar, which afterwards proved of much value when supplemented by corresponding observations at Kandahar. He accompained a force which marched from Kandahar to Kalat-i-Gilzai by the direct route and returned by the Arghandab Valley, surveying both routes and giving out triangulations on which reconnoissances were based by Captain Sartorius of the 59th Foot, and Lieutenant Oliver, R.E., whose services had been made temporarily available for the survey operations. Returning to Kandahar in February, he was first employed by the General in command, in compiling a map of the work already done, and then in aiding in the general survey of the country immediately around Kandahar. During the hot weather he accompanied an expedition to the Khakrez Valley to the north-west; he also took a share in the requisite observations for determining the difference of longitude between Kandahar and Quetta, electro-telegraphically, Major Campbell taking the simultaneous observations at Quetta. In the middle of August he left Kandahar to return to India, with special instructions to strengthen and complete the triangulation down to the points at Quetta. Although the weather was very much against him, owing to great heat and continual dense haze, he persevered with the work and finally succeeded in completing it.*

249. Captain Heaviside carried a route survey with a prismatic compass and perambulator from Quetta to Kandahar, checked by latitude observations

* Major Campbell reports that Captain Rogers had a most arduous year's work, with a greater share than most officers of all the hardships of the campaign, including all vicissitudes of cold and heat, and he deserves great credit for the energy with which he went through it.

at Gulistan Karez, Chaman, and Abdul Rahman. He was then employed in commencing a survey of the Kadanai Districts lying to the north-east of the Khwaja Amran range, in which he was eventually joined by Captain Holdich; and from that time onwards these two officers worked together, the former measuring base-lines, triangulating, and taking check observations for latitude and azimuth; the latter sketching all the ground visible from the hills to which access could be obtained, on the geographical scale of $\frac{1}{4}$ inch to the mile.

250. In the month of March, while still at work in the Kadanai District, Captains Heaviside and Holdich received instructions to join the column under General Biddulph, which was under orders to return to India by a new and unexplored route—the one by which the Mooltan column was originally intended to have entered Afghanistan. They therefore recrossed the Khojak Pass, and surveyed along the southern edge of the Khwaja Amran range to Balozai, the appointed place of rendezvous, where a halt of three or four days fortunately afforded time for the measurement of a base-line, the determination of its azimuth, and the execution of some triangulation connecting with Captain Rogers' points, which proved to be of much value in the subsequent operations. The march was commenced on the 24th March, and was executed at the average rate of 12 miles a day, some of the marches being over 20 miles in length. Fort Munro, on the British frontier, was reached on the 17th April. The route lay through the Bori, Luni, Chamalang, and Kaho valleys, crossing several mountain passes and passing the important villages of Tal and Chotiali, which has led to its being called the Tal-Chotiali route. The rapidity with which the force marched made it impossible to carry a continuous triangulation across the entire breadth of country; thus after a while Captain Holdich was dependent on his plane-table alone, without any extraneous assistance; but on reaching the Sulimani range he met with the trigonometrically-fixed points of the surveys on the Indus, and his connection with these points sufficed to show that, rapidly as his work had been executed and in parts without any extraneous assistance, it was as accurate as could be desired for a survey on the $\frac{1}{4}$ inch scale. From first to last it embraced an area of about 5,000 square miles.

251. Lieutenant Gore had been specially deputed to Quetta in order to make a survey of the Pishin Valley for the Foreign Department. After consultation with the political officers, he decided that the $\frac{1}{3}$-inch scale would be the most suitable for the requirements of the authorities, as regards the amount of detail to be shown and the speedy production of a map of the country. Measuring a base-line in Gulistan, he carried on the necessary triangulation and plane-tabling single-handed, connecting the former as soon as practicable with the triangulation which had been brought up from Sind. He also accompanied an exploring party under Captain Wylie over the Toba plateau, and another under Captain Showers round the east and north boundaries of Pishin, and across a tract of new country stretching from Quetta into the Kadanai plains. He had a very hard season's work, continued without a break throughout the hot weather, and his out-turn is excellent both in quality and quantity, and has been highly commended by General Sir D. Stewart.

252. Lieutenant Hobday carried a route survey from Chaman to Kandahar, diverging whenever practicable from the line taken by his predecessors. He took a large share in the survey operations near Kandahar, including the large-scale survey of the surrounding country and the reconnoissance of the Khakrez Valley. He was much occupied in teaching the use of the plane-table to certain officers (see paragraph 255) who had been temporarily withdrawn from regimental duty to assist in the survey operations. But severe attacks of fever obliged him to abandon field work and go into recess quarters in June. Returning towards India with a portion of the force in August, he was again attacked by fever, but succeeded in making a large-scale survey of the Khojak Pass, during an unusually protracted halt in the neighbourhood. He was shortly afterwards sent to Europe on medical certificate.

253. Major (now Lieutenant-Colonel) Campbell was directed on reaching Quetta to assume general charge of the operations, as the senior Survey Officer in Southern Afghanistan, and to be specially on the look-out to make arrangements with the military and political authorities to make the most of every opportunity which might arise for extending our geographical knowledge. At first he availed himself of an opportunity for visiting the plains of

Shoráwak, with a detachment sent there from Gulistan Karez, and he made a route-survey of about 150 miles, closing on Quetta, through new country between Peshin and the great central desert of Afghanistan. He then took observations at Quetta for determining the difference of longitude between that place and Kandahar by means of the newly-established electro-telegraph line, Captain Rogers co-operating at the Kandahar end. Leaving Quetta on the 8th May, he accompanied the Political Officer, Captain Wylie, and Lieutenant Gore on a trip for the exploration of the hitherto almost unknown table-land of Toba, which was most successful, crossing the plateau in three directions, and thus permitting of the construction of a really good map. He wrote a report of the country which has been printed in the Quarter Master General's Department. Descending from Toba, the party went to Gulistan Karez, where there happened to be a telegraph station. Major Campbell therefore availed himself thereof to determine the difference of longitude with Kandahar electro-telegraphically a second time, Captain Rogers again co-operating at Kandahar.*

254. He then proceeded northwards, taking the route by the Barghana pass, and eventually arrived at Kandahar on the 22nd June, where he took charge of the survey offices and the work of calculations and mapping which remained to be completed. The whole of the maps were submitted in due course to General Sir D. Stewart for approval and transmission to the Commander-in-Chief. On the renewal of hostilities in October, Major Campbell accompanied the force under Brigadier-General Hughes to Kalat-i-Ghilzai, and returned with it to Kandahar in the following month, when, finding that there was no prospect of further survey work until after the winter, he applied for and obtained permission to return to India.

255. Captain Sartorius of the 59th Regiment, Lieutenants Small and Lake of the same Regiment, Lieutenant Baynes of the 60th Rifles, and Lieutenant Oliver of the Royal Engineers, were temporarily employed in the survey operations around Kandahar, and rendered much valuable assistance. Major Campbell specially notices the excellent work done by Captain Sartorius, who is as skilful a draftsman as he was subsequently proved to be a swordsman, in an action with the enemy, when his gallant conduct was the admiration of all eye-witnesses. Captain Maitland, of the 3rd Sind Horse, was also on survey duty for a short time in Pishin, with Major Campbell.

II.—The Operations in the Kuram Valley, and generally to the South of the Safed-Koh Range.

256. When the arrangements alluded to in paragraph 245 fell through, in consequence of the war with Afghanistan, Captain (now Brevet Major) Woodthorpe was attached (with a native surveyor) to the Kuram Column, under General (now Sir) F. Roberts. For four months he was the only officer of the Survey Department serving with the column; but he was aided by Lieutenant Manners Smith, of the Punjab Frontier Force, whose services had been placed at the disposal of General Roberts for survey work. In March 1879, Captain Gerald Martin joined the survey.

Personnel.

Captain R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade.

Captain Gerald Martin, Assistant Superintendent, 3rd grade.

Doing duty.

Lieutenant Manners Smith, Adjutant, 3rd Sikh Regiment.

257. Captain Woodthorpe accompanied the first advance of General Roberts' force to the Peiwar in November 1878, partly along the right (south) bank of the Kuram River, *viâ* Hazir Pir and the Darwaza Pass, and he plane-tabled the country along the route. He was present at and took part in the military operations of the 28th November and of the 2nd and 3rd December; and he had a marvellously narrow escape during the action of the 2nd, when, in the dusk of the morning, he went up by mistake to a breastwork occupied by the enemy, who did not discover his presence till he was within six yards, when they fired a volley at him. The stock of his pistol was smashed by

* Major Campbell reports that the two values of the longitude of Kandahar, as referred by these measurements to the origin of the Great Trigonometrical Survey, agree fairly well, and assign a position to Kandahar which is within a quarter of a mile of the position afterwards deduced on the completion of the triangulation between Kandahar and Quetta. This is as follows:—Trigonometrical station on highest building in Kandahar citadel, near the centre, 65° 45′ 2″ east of Greenwich; a correction of *minus* 2′ 30″ is necessary to reduce this value to the latest value of the longitude of the Madras observatory, which is the origin of the Indian triangulation.

a bullet which grazed his side, and drove a piece of his clothes into his sketch book, which was considerably damaged; but he himself escaped uninjured.

He completed a reconnoissance, on a large scale, of the scene of action; and on the advance of the force he plane-tabled from Peiwar along the Ariob* valley through Alikheyl to Rokian, from which point, owing to the narrowness of the valley and his inability to visit points affording a good view on either flank, he was only able to carry a route-survey to the Shutargardan Pass. He found the position of this pass to be considerably erroneous on the old maps. On his return to Alikheyl he visited the Matunge hill,† about 4½ miles north of Alikheyl, and accompanied the reconnoissance in force through Chapri and Karai in the Mangal country, to Kuram.

* Captain Gerald Martin states that hitherto this name has erroneously been written "Harioh."

† About 12,900 feet above sea-level.

258. In January he accompanied the expedition into the Khost Valley *viâ* Jagi-Maidan, Bahok, and Akubi to Matun, and explored the valley to the west, in the direction of Degan and Ismail Kheyl. During this expedition nearly the whole of Khost was mapped. The Shobakgarh range, between the Kuram River and Khost, was subsequently visited, and the position of the pass over the range into Khost was fixed; a route-survey of the new road from Ibramzai near the confluence of the Kuram and Karmana Rivers, *viâ* Hazar-pir, to Thul, was also completed.

259. In the month of March Captain Woodthorpe visited the hill of Matungeh for a second time, accompanied by Captain Martin. They obtained a good view of the country towards Ghazni, and, notwithstanding the inclemency of the weather, were able to complete a good deal of work. They also visited the Lakarai Pass leading from Alikheyl *viâ* the Surkhab Valley towards Gundamak, and sketched portions of the Tezin and Jagdalak hills, otherwise known as the Karkacha range. During May, reconnoissances were made to the Sirkai and Shutargardan Passes; to the Tarazod peak near the Mangior Pass; to the Istar Pass and head of the Mangior defile, looking over the Ahmed Kheyl country; to the Kafartaga hill and to the Naktek peak over the Ahmed Kheyl and Lajji country, during which the positions of the Ahmed Kheyl and Lajji villages were fixed, and a good deal of the topography south and west of Ali Kheyl was completed.

260. Subsequently Captains Woodthorpe and Martin visited Sikaram, the highest peak on the Safed-Koh range (which had already been ascended from the Jelalabad side by Mr. Scott), with a hope of being able to take observations, from it and other points on the crest of this range, to the peaks of the Hindu-Kush range; unfortunately, however, the condition of the atmosphere was unfavourable for such observations, the hot-weather haze having set in, which shut out all view of far distant ranges.

261. The limits of the survey approximately are, to the east, a line drawn from Thal on the Kuram river to the Agram Pass on the Safed-Koh range; to the north, from the Agram Pass along the Safed-Koh to the Shutargardan Pass; on the west, the water-parting beyond the basins of the Kuram and the Khost valleys; on the south, the range which forms the southern watershed of Khost. The total area mapped covers about 3,000 square miles. The scales of survey adopted were 1 inch to the mile for routes, and ¼ inch to the mile for the geographical work.*

262. On the conclusion of the Treaty of Gundamak, Captains Woodthorpe and Martin proceeded to the survey head-quarters at Mussoorie to complete the mapping; but they had not been there more than a few weeks when they were ordered to return to Kuram, to join Sir F. Roberts in his advance on Kabul. Their subsequent operations form a part of those to be described in the report for next year. Both officers have done much good work. Lieutenant Manners Smith rendered valuable assistance in route surveys, military sketches, and mapping, while attached to the survey party. Captain Wood-

* Captain Woodthorpe reports that the old map of the Kuram Valley* is exceedingly accurate as far as the Peiwar Kotal on the north bank of the river, but he has been able to improve it a little. An interesting narrative of the events connected with these operations, and a general description of the country and its inhabitants, was contributed by Lieutenant Gerald Martin to the October number for 1879, of the "Proceedings of the Royal Geographical Society, London."†

* By Lieutenants Garnet, R.E., and T. Lumsden, 1857.

† See also a paper contributed by Major J. Worthington, Assistant Surveyor General, to the Journal, Asiatic Society, Bengal, Vol. XLVIII, Part II, 1879.

thorpe's very valuable and varied services have been suitably recognised by his promotion to a brevet-majority.

III.—The operations in the valley of the Kabul River, and generally to the north of the Safed-Koh Range.

263. On the formation of the Peshawar column, under General Sir Samuel Browne, in November 1878, Major (now Lieutenant-Colonel) Tanner, Captain Samuells, and Mr. Scott, were attached to the column. Captain Leach joined it in the following month of January, and Captain Strahan in April.

Personnel.

Major H. C. B. Tanner, S.C., Deputy Superintendent, 3rd grade.
Captain C. Strahan, R.E., " " 3rd "
" E. W. Samuells, Assistant " 1st "
" E. P. Leach, R.E., " " 2nd "
Mr. G. B. Scott, Surveyor, 3rd grade.

264. Each of the three first officers accompanied one of the three divisions, which advanced from Jamrud on Ali Masjid by different routes, at the commencement of the campaign. Captain Samuells much distinguished himself by carrying on his plane-tabling under a heavy fire; but, unhappily, he shortly afterwards fell a victim to typhoid fever, and was brought back to Peshawar, to die there on the 21st December.

265. Major Tanner carried a continuous route survey from Ali Masjid to Jelalabad, reconnoitring the ground on each side as far as was practicable. He also measured base-lines and executed triangulations, combined with astronomical determinations of latitude and azimuth at Dakka and Jelalabad. He took a number of observations to the peaks of the surrounding hill ranges, both north and south of the Kabul River; fortunately he soon discovered that several of his points were identical with points which had been fixed several years previously by Captain Carter and other officers, in the course of the operations of the Great Trigonometrical Survey on the Trans-Indus frontier. Thus, though it had not been possible to carry up a triangulation from the British border, these identified points became a basis for the survey operations, enabling them to rest everywhere on triangulation, and be made independent of further astronomical observations. Jelalabad, when connected with them, was found to be about 5 miles nearer to Peshawar than has hitherto been accepted, on the authority of the maps and surveys of former times.

266. In May, Major Tanner undertook an exploration into Kafiristan through the Kunar Valley and Chuganistan, and after several perilous adventures reached Aret; but there, owing to the hardships and exposures incident to the undertaking, his health failed, and, prostrated by fever, he was compelled to abandon his design and return to Jelalabad, which he was able to do through the friendly aid of the Chugani Chief, Azim Khan, and the Malik of Jinjapur.

267. Captain Leach joined the force in January, and during the two months he was at work, surveyed a good portion of the Bazar valley and the country round Jelalabad, chiefly in the Shinwari country and on the northern slopes of the Safed-Koh range. At the end of March he was compelled to withdraw from all active share in the operations, in consequence of a severe wound received during an attack on his party by Shinwaris, near the villages of Maidanak and Girdi; his gallantry on that occasion has won for him the honoured distinction of the Victoria Cross.

268. Captain Charles Strahan joined early in April, *vice* Captain Leach. He executed a survey of the country between Safed Sang and Surkpul, and about 80 square miles north of the road up to the Surkhab River; he also made a rough sketch of the Siah-Koh beyond, up to the crest of the first range; and subsequently he was able to visit the Siah-Koh, and complete some useful observations to peaks on the Hindu-Kush and in Kafiristan. From and around Safed Sang he fixed by triangulation nearly all the prominent peaks visible on the Safed-Koh and Siah-Koh ranges; and some on the Karkacha range to the west, which will be most useful for the extension of survey operations toward Tezin and Kabul.

269. Mr. G. B. Scott made a variety of sketches on the scale of 2 inches to the mile, in the country to the south of the Kabul River, and between Jamrud and Dakka, in the Bazar valley and in the Shinwari country. In February he was surveying a new route on the north bank of the Kabul River, accompanied by a small escort, when he was attacked by a strong party of Mohmunds, and a hand-to-hand fight ensued in which he displayed great gallantry and good judgment, thereby probably saving his whole party from

destruction. Later on, during the prolonged halt at Jelalabad, Mr. Scott visited the peak of Sikaram (Sikkarram),* the highest point on the Safed-Koh range, where he obtained observations to distant peaks all round, including a very prominent peak to the north, which he describes as "a pyramid standing far above the heads of all the surrounding peaks of the Hindu-Kush." These observations will be very useful when they can be supplemented by corresponding observations from other stations.

* Also called Said Karrambaba-ka Ziarat.

270. The work completed in this section of the operations falls between latitude 33° 55′ to 34° 30′, and longitude 69° 45′ to 71° 30′. It covers an area of about 2,200 square miles, and extends from Forts Michni and Jamrud on the British frontier near Peshawar, to the Surkhab River west of Gundamak, including a little of the northern and most of the southern portion of the basin of the Kabul River. On the northern slopes of the Safed-Koh, in the country of the Shinwaris and Khagianis, some blanks remain, which were unavoidable owing to the conditions under which the survey in an enemy's country was conducted.

271. A considerable amount of valuable geographical information was also obtained to the north of Jelalabad, in the Dasht-i-Gumberi plain and the Lughman Valley, from the Daronta Pass to the junction of the Alishang and Alingar rivers; and a more extended sketch, based upon triangulation, was obtained, of the surrounding heads and hills of the above river valleys and extending westward to the Badpukt and Tang-i-Shaidan Passes. Mr. G. B. Scott was also able to compile a fairly useful map of Tirah, chiefly from native information based on points fixed by the triangulation.

IV.—Report on the experience gained regarding the sufficiency of the general organization of the Survey Operations during the Campaign in Afghanistan.

272. The Secretary of State for India has intimated a desire that the experience gained during the recent campaign on the work and organization of the several departments engaged, directly or indirectly, on the conduct of the campaign, shall be reported on and recorded, "both as regards those measures which on trial have failed, and those which have succeeded," in order that what has already been gained at great cost will not have to be re-bought, should an army be required again to take the field under similar circumstances. The present appears to be a suitable place for recording this information, as regards the Survey Department.

273. The only measure which can really be said to have been "on trial," as regards the survey operations, was the proper equipment of a number of officers, suddenly collected together from various parts of India and even from England, for the duties which they might be expected to perform. In a few instances it was possible to send officers directly from head-quarters or from survey parties to join the army, with an equipment of men and instruments selected by themselves. But in a majority of instances it was not possible to do so, as when officers were summoned out from England, or sent up from parts of India at a considerable distance from the frontier; it was then necessary to send instruments, and a few native surveyors and khalasees collected from the nearest survey parties, to meet these officers at some point on the frontier—as Sukkur, Multan, or Peshawar—to which they were required to proceed by the shortest possible routes from the places where they received their orders to join the army. The officers who were in a position to select their own men and instruments, appear to have been fully satisfied with their own arrangements, as was but natural. Of the remaining officers, none has had any fault, worth mentioning, to find with the instrumental equipment which had been provided for him, with the exception of a single officer, who has reported that if he had not succeeded in securing a spare set of instruments which had been sent up and arrived in good condition, he would have been unable to do anything, as the instruments sent for himself proved on arrival to be unserviceable.

274. As regards the equipment of native surveyors and men, an equal amount of satisfaction has not been expressed. Some officers appear to have almost expected that they would find a complete and well-organized survey party ready to meet them the moment they reached the frontier, and to accompany them into the

enemy's country beyond. But to arrange for the formation of such parties was impossible during the short time available; for the whole of the subordinates of the survey establishments, both Europeans and Natives, are civilians; and though many of them would gladly volunteer to serve in an enemy's country, none could be expected to go there as a matter of course. Moreover, isolated Hindustanis run a very great risk of being murdered in Afghanistan; thus it seemed desirable for each officer to entertain Pathans, Belúchis, or natives of the country on the border—to be employed as instrument-carriers, and generally in the menial operations of the survey—and not to take more Hindustanis with him than was essentially necessary, in order to secure the assistance of a few trained hands. Little difficulty appears to have been experienced in entertaining as many men of the border as were wanted, on the high wages then being given to the camp followers; but it appears from the reports which have been received, that only a few of the officers were satisfied with these men; the majority would have preferred employing trained Hindustanis.

275. The native surveyors who were sent to Afghanistan were mostly men who could traverse with the theodolite and chain; they were found serviceable in carrying route-surveys along the lines marched over by the troops, while their officers diverged to the right and left, and sketched as much of the country as they could get sight of. This was what they were chiefly intended to do. Some disappointment has, however, been felt at the small proportion of these men who could sketch with a plane-table, write English, and compute skilfully; but the number of natives in the Survey Department who possess all those qualifications is very small, and it would have been scarcely possible to send more of them to join the army than actually were sent. As already observed, none of them are bound to serve beyond the frontier; and though natives of Hindustan will willingly accompany any European officer whom they know, and can trust to look after their welfare and interests, wherever he may happen to be sent, they will not readily volunteer to serve in an enemy's country under officers whom they have never seen, and of whom they know nothing.

276. Thus the lesson to be drawn from the experience of the past, is that officers of the Survey Department, when about to be sent to join an army in the field, should, if possible, be given sufficient time beforehand to select their own instruments and men, the latter more particularly, so that they may start fully equipped with all they require, instead of having to depend on instruments which may have to be sent to them from a great distance, and on men collected at haphazard from various quarters. Still, however, the late campaign has abundantly shown that much excellent work has been done by officers who have not possessed these advantages, but have raced to the front as fast as they possibly could go, picking up men and instruments, camp equipage and horses, wherever they could find them on the road, and depending on the natives of the border—and even of the invaded country—to supply deficiencies in the personnel of their parties.

277. So much for the only measure which may be said to have been "on trial." There are, however, other points which are familiar to the officers of the Indian Survey Department, but are less well known in the army generally, which may be here noticed.

278. The duty of a survey officer, campaigning with an army in a comparatively unknown country, is to obtain general geographical information over as wide an area as possible, as well as to execute a minute and exact survey of the lines of route followed by the troops to which he may happen to be attached. When the troops march with great rapidity, it is impossible to do more than make a continuous survey of the route, excepting under very favourable conditions in the lie and general configuration of the ground, giving commanding points within easy reach of the line of route. When the troops halt anywhere for a few days, frequent opportunities of reconnoitring the surrounding country may occur, which it will be desirable to make the most of, not only for geographical considerations, but with a view to subsequent military operations.

279. The instrument *par excellence* for such work is the plane-table, either in the form in which it is so extensively used in almost all survey operations in India, or in a modified form giving greater lightness and portability, and yet retaining the special characteristic of the instrument in enabling the ground to be mapped on the spot, under direct ocular evidence, instead of elsewhere,

on the evidence of observations recorded in note-books. If a good planetabler is given a base to start from, of which the length and azimuth are correctly known, and ground to operate in, with a fair proportion of commanding positions and hill peaks which are susceptible of ready identification, he can survey with great rapidity; first, fixing new points, should this not have been done for him beforehand, by triangulation; then using these points in their turn to fix his forward positions, and from them again fixing other points, and so on, until he has laid down all the surrounding country, to a distance much beyond the positions which he may have been actually able to reach. Thus it will be seen that a plane-table is a most valuable and necessary adjunct to the instrumental equipment of a survey officer attached to an army.

280. When the troops march very rapidly, and the route lies through a country which is flat and devoid of commanding positions, or in valleys which are hemmed in by inaccessible hills, or in tracts of forest, the plane-table is at a disadvantage as compared with the theodolite; for, in such circumstances, the usual method of route-surveying with a theodolite and chain or perambulator, or with a subtense instrument, and recording the observations on the spot and subsequently working out the results, either by calculation or protraction, may be expected to give a better and more accurate route-survey than would be got by plane-tabling.

281. There will be more or less of liability to error in all survey operations which are conducted with great rapidity, as pre-supposed above, both for the plane-table and the theodolite surveys; it is therefore desirable to check the operations from time to time by astronomical observations of latitude and azimuth; also by absolute longitude observations as well, whenever the troops are encamped long enough at any place to permit a sufficient number of observations being taken; or, better still, by differential longitudes, determined electro-telegraphically, whenever a line of telegraph has been established with the army. Thus the survey officer with an army should be supplied with a suitable instrument to enable him to take astronomical observations for the determination of latitude, azimuth, time, and longitude.

282. For this reason, several of the survey officers in Afghanistan were supplied with a 6-inch transit theodolite,—an instrument which has a complete vertical circle, and an eye-piece fitted with a pair of "subtense micrometers," which are intended to measure small angles subtended by distant objects in the field of the telescope. It is described in General Thuillier's "Manual of Survey for India" (3rd edition, page 132); also in "Hints to Travellers" by the Royal Geographical Society, 4th edition, page 33. It may be called a universal instrument; for it is not only well fitted for astronomical observations, as well as the ordinary measurement of horizontal angles, but it enables the distances of objects of known length to be determined very readily, with the aid of the subtense micrometers, thus permitting measuring chains to be dispensed with in running traverses and measuring base-lines. It requires delicate manipulation, but in skilful hands it is capable of yielding admirable results. It weighs 31 lbs. when packed in its box, the stand weighing 10 lbs. more, and it is probably the lightest instrument yet constructed which is capable of such universal application.

283. A few 4-inch and 5-inch theodolites were also supplied; the former are particularly useful when a very light and handy instrument is required, which can be carried about on horseback; for their weight, when packed, is less than 15 lbs., and they pack into a small box.

284. The plane-tables were of the ordinary pattern and size, 30″ by 24″, as constructed in the Mathematical Instrument Department at Calcutta, with magnetic compasses, sight rules, and tripod stands. Their weight is nearly as follows:—

Plane-table	11 lbs.
Sight rule and magnetic needle . . .	2 „
Tripod stand, folding 8lbs., or braced . .	12 „

For a full description of the instrument, see pages xxiii and xxiv of the Appendix to General Thuillier's "Manual of Survey," 3rd edition. Its weight and bulk are its only objection, as it cannot be conveniently carried about by less than two men, one for the table, the other for the stand; but our officers appear to have succeeded in getting their plane-tables taken up to every point, however high and difficult of access, which was reached by themselves during the

campaign. The paper is mounted on the table; but by employing paper which is mounted on strong cloth and may be rolled up without injury, and pinning the portion which is being drawn on, down to the table, much smaller tables may be used, thereby materially diminishing the weight, and larger sheets of paper could be employed, which would sometimes be found an advantage.

285. The amount of clerical work which had to be done by the survey officers, in the preparation of bills of all kinds and indents for carriage and rations, was occasionally found to be very trying and to interfere greatly with their ordinary work. Making copies of their surveys as fast as completed, for the use of the military and political authorities, and for the Surveyor General's Office, was also found to be a great and serious tax on their time. A light and portable machine for reproducing maps would have been invaluable to each officer, and enquiries and experiments are now being made with a view to producing something of the kind, which may be of service hereafter. It is desirable that every survey officer should, whenever possible, have the assistance of a native surveyor or draftsman to make tracings of his maps and perform all such clerical work as may be wanted.

286. It may be added that an officer requires to be well skilled in each of the several branches of survey operation, in order that he may be in a position to make the most of all the opportunities which will be afforded him of achieving a survey of an enemy's country. He should be fertile in expedients for carrying on his work, without material error, whenever any breaks of continuity occur in consequence of the rapidity of the movements of the force which he is accompanying. He should be a good practical astronomer, a good computer, a good observer, and a good draftsman. In the ordinary routine of work, in the Survey Department, there is a division of labour, of which the result is that an officer may become highly efficient in certain portions of the survey operations, and yet know nothing practically of the others, because he has not had, and is unlikely to have, any call or occasion to undertake them. Thus the officers selected for the survey operations in Afghanistan were chosen in equal proportions from the three branches—the Trigonometrical, the Topographical, and the Revenue—of the Survey Department, in order that some officer might be present, with each column, who would be qualified for at least one if not more of the operations—astronomical observation, triangulation, route-surveying, and topographical plane-tabling—which might be required at any moment. The conjoint operations of these officers have furnished results which may be pronounced decidedly satisfactory, in quantity as well as quality, considering the manifold difficulties under which they were accomplished.

XXIX.—TRANS-HIMALAYAN EXPLORATIONS.

287. The Appendix to the present Report contains accounts of three explorations which have been made of late years by our trained native explorers, but of which the details have not yet been published. Each of these accounts is illustrated by a map.

288. The first, by Lieutenant Harman, R.E., gives the details of an exploration, in Eastern Tibet, of a portion of the valley of the Sanpo River, lying considerably to the east of the portion which had been previously explored, and lower down in the course of the river, bringing the survey down to Gyala Sindong, a fort which is situated within 100 miles of the highest point yet reached in the survey of the Dihong River. The latter river is the principal affluent of the Brahmaputra, and has long been supposed to be the channel through which the Sanpo River flows into the Brahmaputra. This last exploration of the Sanpo adds much probability to that supposition, but still leaves it an hypothesis; and so it must remain, until further explorations are made, or logs of timber can be floated down from Gyala Sindong into the Dihong; the intervening belt of country is inhabited by wild tribes called "Abors," who, from time immemorial, have not allowed any individual to pass through their hills, from Tibet into Assam, or *vice versâ*. Lieutenant Harman is now endeavouring to arrange to have a number of logs specially marked at Gyala Sindong, and floated down the river; and if this can be done, and the logs are found to emerge in the Assam valley, the question whether the Sanpo

eventually enters the Brahmaputra or the Irrawaddy will be conclusively disposed of, even without further surveys.

289. The second section of the Appendix gives an account, by Mr. Hennessey, F.R.S., of explorations in South-Eastern Tibet, in 1875-76, by explorer L——, who started from Darjeeling to carry a route-survey through Sikkim and *viâ* Gánpá (or Khamba) Jong to Shigatze, and afterwards to explore the lower course of the Sanpo River as far as might be practicable. The direct road from Sikkim to Shigatze had not previously been surveyed, as it crosses a frontier line which is guarded with much jealousy by the Tibetans. The explorer crossed this line, and was soon afterwards taken prisoner; but fortunately, instead of being sent back into Sikkim, he was sent on in the very direction he wished to go, first to Gánpá Jong and then to Shigatze; he was able to keep up an itinerary all the time, which gives a fair amount of useful information, though it is not nearly so valuable as it would have been if he had succeeded in passing through the country without being discovered. After some months' detention at Shigatze, he was set at liberty, and proceeded down the valley of the Sanpo River for a distance of about 200 miles, surveying as he went. The lowest point which he reached on the Sanpo River was the town of Chetang, the position of which had already been fixed by Pundit Nain Sing, in exploring the route between Lhasa and the Assam Valley *viâ* Táwáng. Being told that further progress down the Sanpo would be impossible for him, unless in company with a strong body of men, he turned southwards with the intention of getting into Assam by the route previously taken by Nain Sing. But on reaching Táwáng he was prevented from proceeding to Assam, and had to retrace his steps to Shigatze. Eventually, he returned to Darjeeling by the route *viâ* Giangche Jong and Phari, which had been partially traversed by Captain Turner in 1783.

290. The last section of the Appendix (commencing at page XIX) is devoted to a narrative of explorations by "the Mullah," in the Swat and Indus valleys, and the Kohistan between them.

291. It will be seen in the Annual Report of the Trigonometrical Survey for 1876-77, that in the year 1876 the Mullah made surveys up the course of the Indus from the British frontier to the junction of the Gilgit River, and from Yasin westwards to Sar Laspur and Mustuj, and then down the Panjkora valley *viâ* Lamúti to Dodbah, with lateral diversions to Nowagai, Kunar, &c., eventually re-entering British territory at the fort of Abazai near Peshawar. He had thus acquired much valuable geographical information of the regions by which the Swat valley is surrounded on all sides; but he had nowhere touched that important valley itself, which as yet remained unsurveyed, together with several important lateral *durrahs* or glens leading into it, and others into the valley of the Indus. To obtain information of the regions included within the circuit of his previous surveys, was the object of the present exploration. He started from the Fort of Abazai, and passing through Totai, crossed the range of hills which form the northern fringe of the Peshawar basin, and entered the lower portion of the Swat valley, near the junction of the Swat and Panjkora Rivers, a point of considerable geographical importance, which he was able to fix. He then proceeded up the Swat valley, making excursions up the principal lateral glens on the right bank, until he reached Kálám, in the Kohistan, in which the sources of the river are situated. He surveyed the route from Kálám westwards to Lamúti in the Panjkora valley, in order to connect his present with his previous explorations; and then, returning to Kálám, he continued to work up the Swat River, until he approached the water-parting of the important but little-known range which stretches longitudinally from a point on the Indus River below Gilgit to the Chitral River, and the southern spurs of which form the water-partings between the Indus, the Swat, the Panjkora, the Dir, and the Kunar-Chitral basins. He crossed over the Palesar Pass into the Kandia valley, one of the principal lateral valleys on the Indus, and worked down to its junction with the Indus, where he joined on to his first survey. He then turned southwards, along a route running parallel with the Indus, but several miles to the west, crossing the whole of the lateral valleys on the right bank of that river, and acquiring much additional information to combine with his first survey, which he joined on to at several places for the verification of his work. Finally, he surveyed the important routes which lead

from Kabulgram and Takot on the Indus, *viâ* Aloch and Chakesar, to the large villages of Manglor and Chahár Bágh in Swat; he closed work at a point on the line of his survey up the Swat valley.

292. The work fits fairly—quite as well, in fact, as is to be expected of any route-survey depending on compass bearings and paced distances—into the skeleton framework furnished by the peaks of the hill ranges which had been previously fixed in the course of the operations of the Great Trigonometrical Survey. It is a valuable addition to our knowledge of a region of much interest, into which Europeans have not yet penetrated. The narrative of the Mullah's exploration has been literally translated from his own journals and *viva voce* statements, and is very creditable to him for the information obtained and furnished; it is, moreover, a genuine story, told with a touching simplicity, of perils and privations steadily faced and patiently surmounted. A few notes have been added by Lieutenant-Colonel H. C. B. Tanner, as the narrative was being passed through the press.

XXX.—SURVEYS AROUND GILGIT.

293. A period of about twenty years has elapsed since the late Major Montgomerie and his Assistants were employed in survey operations on the north-western border of the dominions of the Maharajah of Kashmir. At that time the relations between the Maharajah's Government and the people of Gilgit were so unfriendly that the topographical operations could not be carried across the Indus, though many points on the hill ranges beyond had been fixed by the triangulation. Of late years, however, matters have much improved, and now British officers not only go to, but reside at, Gilgit. Thus the time has arrived when the survey operations may be extended beyond their previous limits, so as to give additional topography, and also a further extension of the triangulation, in order to fix prominent points on the Hindu-Kush and other hill ranges which are still inaccessible to Europeans.

294. Major (now Lieutenant-Colonel) H. C. B. Tanner, Deputy Superintendent, 3rd grade, was selected for this duty on his return from Jelalabad and the southern frontiers of Kafiristan (paragraph 266); for it seemed probable that he might be able to discover a more easy entrance to Kafiristan from the north-east than from the south, and thus eventually achieve the exploration of that country from the direction of Gilgit. His first task, however, was to extend the regular survey operations over Gilgit, and he has satisfactorily succeeded in mapping, on the $\frac{1}{4}$-inch scale, an area of about 2,000 square miles, extending from Búnji on the Indus to Hopar on the Yasin and Ponyál frontier, and embracing the lower 35 miles of the valley of the Hunza River, immediately above its junction with the Gilgit River; also the Bagrot and Naltar valleys, and some minor lateral streams. Much difficulty was experienced in mapping the great range of hills which lies to the south of Gilgit, and runs in a nearly longitudinal direction from the Indus to the Kunar-Chitral River, and of which the southern spurs form the water-partings between the Indus, Swat, Panjkora, Dir, and other valleys on the frontier of Peshawar, already mentioned in paragraph 291. Colonel Tanner states that the central backbone of this range may be described as a huge broken table-land, running up into wave-like ridges which rise but a few hundred feet above the general level of the range; the ridges and peaks on the central backbone are all of nearly the same height, and very similar to each other in appearance, and consequently they are not easy to identify from points more than a few miles apart. For this reason very few of the peaks, and those only at the western end of the range, where its character seems to revert to what is usually met with in mountain ranges, had been fixed by the Great Trigonometrical Surveyors; and even Colonel Tanner, who succeeded in approaching much more closely to the range than they were able to do, has been unable to fix any of its peaks with accuracy; he has, however, determined several approximately, and also the positions of some of the passes leading over the range.

295. Colonel Tanner was at work with two native surveyors all through the months of September and October, which are ordinarily very favourable for survey operations in the Himalaya; but this year the weather was most

unpropitious: snow-storms were frequent and the higher mountains were constantly cloud-capped. Thus it happened that, though Colonel Tanner succeeded in ascending some peaks of considerable altitude, from the summits of which Tirich Mir—the high mountain on the Hindu-Kush range, recently brought to light by Major Biddulph—and other prominent peaks, are visible in the distance in fine weather, he could rarely see more than the lower portions of innumerable glaciers, as they became occasionally revealed by the shifting curtain of cloud. Thus a good deal yet remains to be done for the geography of the surrounding regions, to the north more particularly—in Kunjut, Shimshal, and the Tagdumbash Pamir—all of which is still *terra incognita*, but which will not long remain so, should Colonel Tanner have an opportunity of penetrating into it or even of reaching its outskirts.

XXXI.—THE TIDAL AND LEVELING OPERATIONS.

296. In accordance with the programme of operations for obtaining a "systematic record of tidal observations on Indian coasts," which is set forth in section XI of the Report on the Operations of the Trigonometrical Survey in 1876-77, tidal instruments have been set up and are now in operation at the following ports, *viz.*, Bombay, Kurrachee, Kárwár, Madras, Vizagapatam, Paumben, and Beypore. Captain Baird has also visited various other ports and places as follows: False Point, the Hooghly, Port Blair, Table Island of the Coco Group, Mergui, Moulmein and Amherst, Rangoon, Elephant Island, Bassein and Diamond Island, Kyouk Phyoo, and Akyab,—with a view to ascertain their suitability for tidal stations.

Personnel.

Captain A. W. Baird, R.E., Assistant Superintendent, 1st grade.
Mr. C. J. Neuville, Surveyor, 2nd grade.
„ T. H. Rendell, Assistant Surveyor, 1st grade.
„ E. J. Connor, „ „ 1st „
Narsing Dass, Dhondu Vinayek, and 7 Sub-Surveyors and Recorders.

297. At Bombay the self-registering tide-gauge on the Apollo Bunder is reported by Captain Baird to have been working most satisfactorily. "The clock keeps good time, the curves on the diagram are beautifully formed, there being no eddies or irregularities in the action of the tidal wave. The work on the whole is excellent, and there is no trouble whatever in obtaining the values of the heights from the diagrams for calculation. The clerk in charge, who was appointed by the Port Trustees, has performed his duties very satisfactorily throughout." The Apollo Bunder was originally selected as a provisional site for the tide-gauge, pending the completion of the Prince's Dock, when the instruments were to be moved there. But Captain Baird has proposed that the Dock, when completed, shall be provided with a separate set of instruments, so that observations may go on simultaneously at both places. A single clerk can attend to both sets of instruments, and thus no extra expense would be incurred for supervision. His Excellency the Governor, Sir Richard Temple, has supported Captain Baird's proposals and moved the Port Trustees to sanction the cost of an additional set of instruments.

298. At Kurrachee the old small-scale tide-gauge, set up for Mr. Parkes, was employed throughout the year. Its position has, however, been shifted, and it has been modified and improved by Mr. Humby, Sub-Engineer, whose recent and premature death is much to be regretted. Captain Baird expects to be shortly in a position to replace the present instrument by a large-scale gauge, similar to those which are now employed at all the other ports.

299. At Kárwár the observations have proceeded satisfactorily throughout the year, without any important interruption of continuity; the clerk in charge of the tide-gauge was most attentive, the light-house keeper on the Oyster Rock looked carefully after the anemometer, and the Port Officer took much trouble in supervising the operations generally.

300. At Aden the old tide-gauge was taken down in August 1878, as no one was available to take charge of it. Some delay occurred in setting up a new gauge, because the design originally proposed for the platform of the observatory was so costly that another design had to be made. The new gauge was started in March 1879, and it has been working very satisfactorily ever since, under charge of a clerk appointed by the Political Resident.

301. At Madras the construction of a tidal observatory, underneath the shore end of the pier, was commenced in October 1878. When completed, and the piping connecting the well of the gauge with the sea had been laid, it was found that water would not enter the well; a very troublesome examination and testing ensued, when it was discovered that an india-rubber disc had been inadvertently introduced instead of a ring, or annulus, of the same material, in the fitting of the pipes, and this had effectually prevented the access of water to the well. Matters were righted by the 1st February, when the self-registering tide-gauge was fairly started; it operated satisfactorily from that time until the occurrence of the cyclone of the 20th May. The piping connecting the gauge with the sea, and which had been laid along the beach, was then destroyed by the surf. An attempt was made to restore the connection by a piping laid a little below the roadway of the pier and fully 10 feet above the highest level reached by the sea; but for this purpose the piping would obviously have to be converted into a syphon, and arrangements would be needed to fill the syphon with water and expel all the air inside; on trial it was, however, found impossible to expel the air, presumably because of the length of horizontal tubing, about 600 feet, between the gauge and the sea; this plan had therefore to be abandoned. Eventually it was determined—with the sanction of His Grace the Duke of Buckingham, who has taken much interest in the observations from first to last and caused Captain Baird to be given every assistance by the local officials—to remove the gauge from the shore to the sea end of the pier, where it may now be erected without interfering with traffic; it will thus be in direct communication with deep water, and may be expected to give no more trouble. Meanwhile the observations have been suspended.

302. At Vizagapatam the tide-gauge had been registering satisfactorily for some months, when, on the 6th December 1878, a cyclone occurred which destroyed the observatory, and even carried away the iron cylinder in which the float works; the instruments were fortunately got away without having received much damage. Captain Baird proceeded as soon as possible to the spot, and by the 1st February matters were righted, and the tide-gauge was again in operation, and has continued to work satisfactorily.

303. At Paumben the tide-gauge has been working satisfactorily throughout the year, the interruptions being slight and unimportant. The safety of the observatory was considerably imperilled in December, because of the heavy seas then prevailing; but the precautions taken by the Port Officer, Mr. Baker, were happily successful in preventing any damage from being done.

304. At Beypore the tide-gauge was fairly started in December 1878, and has been working satisfactorily ever since.

305. Captain Baird has applied the Harmonic Analysis method to the calculation of the following tidal constants: for Bombay, from the observations of 1878; for Kurrachee, from those of 1874-75; for Kárwár, from those of the year commencing on 1st March 1878; and for Aden, from observations taken in 1877-78. The numerical values of these constants are given in the appendix. The reductions of the observations at the remaining stations will be taken in hand as soon as a year's continuous observations are forthcoming for each port. It has already been shown at length, in the Annual Report for the Trigonometrical Survey for the year 1876-77, that the determination of the tidal constants enables future tides to be predicted, either by a process of calculation which is very laborious, or with the aid of a machine which has been devised for the purpose of saving that labour. A tide-calculating machine has been constructed in England, from designs supplied by Mr. Roberts of the Nautical Almanac Office, which was originally intended to have been sent out to Captain Baird, to aid him in the preparation of tide tables for each of the Indian ports. This machine has been considered a great success, so much so that it has been retained in England, in order to be available for the requirements of the Admiralty and of Civil Engineers in charge of harbour works. The tide-tables for Indian ports will therefore have to be prepared in England so long as the machine remains there, Captain Baird continuing as at present to compute the values of the constants, and sending them to Mr. Roberts, or whoever else may be entrusted with the manipulation of the machine.

306. Sites have been selected for future tidal stations at False Point, Port Blair, Mergui, Moulmein, Amherst, Rangoon, Elephant Point, Diamond Island,

Kyouk Phyoo, and Akyab. Table Island of the Coco Group had been suggested by the Government of India as a suitable site; but it is difficult of access, and rarely visited, excepting when the light-house is being inspected, or supplies are sent to the man in charge. This man is not able to regulate the clocks and supervise the instruments; they cannot therefore be put under his care. Captain Baird proposes the establishment of two or three stations in the Hooghly in order to provide tide-tables for the river; but it is possible that the tidal observations which have been taken at various points on the river of late years, by officers of the Irrigation Department, may be found to furnish sufficient data for the purpose in question.

307. The spirit-leveling operations, which are being conducted *pari passu* with the tidal observations, have made good progress. This year they have been carried on chiefly in the Bombay Presidency. The main line, from Bombay *viâ* Poona to Satára, has been carried *viâ* Kolhapur, Belgaum, and Dharwar, to Hubli; at the latter place a junction was effected with the line connecting Bangalore and Bellary with the sea-level at Kárwár, which had been executed in previous years. The main line on the Great Indian Peninsula Railway has been extended from Kedgaon to Keim. Various branch lines have been run, to connect important local bench-marks and stations of the Trigonometrical Survey. The aggregate length of line completed amounts to 396 miles, fixing the levels of 389 permanent marks.

308. Captain Baird has worked with his usual devotion and assiduity, often under very trying circumstances, as at Madras and Vizagapatam. He acknowledges the hearty support he has met with from the Governments of Madras and Bombay; he also reports that Captain J. H. Taylor, the Master Attendant of Madras, has rendered much valuable assistance, and the Port officers generally have taken much interest in the operations. Captain Dundas Taylor, the Superintendent of Marine Surveys, has accompanied Captain Baird in several of his inspections, and afforded him much support; and together they have drawn up a set of rules for the guidance of the officers in charge of maritime surveys, of which the object is to ensure the soundings on the charts being referred to the same line of reference as that which will be employed in the preparation of the tide-tables.*

Leveling operations in connection with Revenue Surveys.

309. For some years past it has been customary, whenever possible, to carry lines of levels at intervals of a few miles apart, over the districts of which revenue surveys, either mouzawar or cadastral, were being made, in order that the heights of all the most important points in the district might be determined, which was not possible otherwise than by special operations for the purpose. In this respect there is a very essential difference between the methods of operation in the topographical and the revenue surveys. The heights of most of the survey stations and other objects of importance can be readily determined by the topographical parties, *pari passu* with the operations for fixing the positions of the several stations and objects; but by the revenue parties the heights cannot be determined in the regular routine of work; they must be either abandoned altogether, or be specially provided for by an additional agency.

310. This arises from the circumstance that the topographical surveys are constructed on a trigonometrical basis, and the theodolite stations are always situated on positions which are more or less commanding, and from which observations of vertical angles can be taken, mutually, and to surrounding objects, however distant, *pari passu* with the measurement of the horizontal angles. The revenue surveys, on the other hand, are constructed on a basis of traversing, which follows the boundaries of the villages, and is altogether dissociated from the facts of the general configuration of the ground. The theodolite stations are usually planted on the bends of the boundaries, and invariably at the trijunction points of villages. They are far more numerous than those of

* Captain Baird reports that Mr. Rendell works very well when actually out on observatory inspection duty, and is then very useful; that Mr. Connor has rendered very valuable and willing aid in the reductions; that Narsing Dass continues to give great satisfaction in the spirit-leveling; and that Dhondu Vinayek is the most useful of his Native Surveyors, for the good quality of his work, and his readiness to go wherever wanted at a moment's notice.

the topographical survey, and though vertical angles might be taken at each station to the next, to determine the heights, these observations would greatly retard the other and more important operations; they would also be liable to be very inaccurate, because of the momentary variations of refraction in rays closely grazing the surface of the ground; and while giving a number of heights which would be comparatively useless, they would not give the heights of a number of points which are of much greater interest and importance in a general map of the country.

311. Thus, whenever the determination of heights has been added to the ordinary operations of a revenue survey, it has been provided for by the formation of a small additional party to carry lines of levels over the country, by the method of spirit-leveling, which is well suited for the purpose, and is indeed more accurate than the topographical method of vertical angles.

312. But to provide funds for the payment of this extra party has always been a difficulty. When the leveling operations were first started, in 1868, it was intended that their cost should fall on the Survey Department, and an extra grant was assigned for the purpose. Subsequently, it was decided that levels should only be taken when required with a view to new irrigation projects. Thus, in certain districts of the North-Western Provinces and Oudh, the cost has been met by budget grants of about Rs. 5,000 annually, for each party employed, from the Department of Public Works, in consideration of the great additional value of the map to the officers in the Irrigation Branch, when all the most important levels are shown on their maps. In other districts that Department has declined to defray the cost of the levels, as the levels were not required for new irrigation works; and then they have not been executed.

313. During the past year, leveling operations have been carried on only in the Banda District. The programme of levels for that district has now been completed; 15 lines have been measured at an average of $2\frac{1}{2}$ miles apart, fixing 355 bench-marks, or, on an average, one bench-mark to every 2 square miles of country operated in.

314. The topographical survey of the Saharanpur and adjoining districts of the North-Western Provinces, which is now being carried on by a revenue survey party, does not execute any leveling; but the country has already been extensively leveled over by the Department of Public Works, whose lines of levels have been connected together and reduced to a common datum by the Trigonometrical Survey. The several bench-marks are now being connected with the traverses of the revenue party, and thus all the most important determinations of level will be shown on the maps of the survey. Similar steps should be taken whenever possible in future, in order that the deficiencies of the revenue survey maps may be supplemented, without any sensible increase of expenditure, by utilising the work of any other department which may be ready to hand.

315. The Chief Commissioner of British Burma has recently proposed that levels should be taken by the cadastral parties in his province, as the survey proceeds, and has enquired what the additional cost would be. It may be possible for a single leveling party to do all that is wanted for both the cadastral surveys; if so, the cost of the general survey would be increased by only 2 to 3 per cent., which will be a small additional outlay as compared with the additional value imparted to the maps.

XXXII.—GEODETIC.

316. The electro-telegraphic operations, for the determination of differences of longitude, have remained in abeyance since the completion of the operations described in section XII of the Report of the Trigonometrical Survey for 1876-77. The services of the two officers, Major Campbell and Captain Heaviside, who would have been employed on the operations, have been required with the army in Afghanistan.

PART II.

THE OPERATIONS AT THE SEVERAL HEAD QUARTERS OFFICES.

317. These offices comprise—

(1) The Surveyor General's Office.
(2) The Revenue Survey Office.
(3) The Lithographic Office.
(4) The Photographic Office.
(5) The Mathematical Instrument Office.
} All in Calcutta.
(6) The Trigonometrical Survey Office, at Dehra Dun.

318. The five offices in Calcutta are still located, unfortunately, in separate buildings, the Revenue Office being at a considerable distance from all the others. Very deficient in suitable accommodation when last reported on, they are even more so now, because they are incapable of expansion to meet the growing requirements of the Department, and to provide space for the annual increase in the stock of maps for general issue. More than half the present stock is kept in a corrugated iron shed which is liable to be carried away by the first cyclone, and the drawing and engraving rooms are even more overcrowded than formerly. At last, however, there appears some probability that a commencement will shortly be made of a building to contain the Surveyor General's and the Revenue Survey Offices under one roof, on the site which was purchased for the new offices in 1873, but which has not yet been built on. These two are the most important of all the offices, and it is highly desirable that they should be located in one and the same building as soon as possible. The houses in which the Lithographic and Photographic Offices are located are situated in such close vicinity to the site for the proposed new building that there is no immediate necessity for erecting new buildings for them also, although it will be desirable to do so as soon as funds can be conveniently assigned for the purpose.

(1) THE SURVEYOR GENERAL'S OFFICE.

319. In addition to his duties as Superintendent of the Lithographic and the Mathematical Instrument Offices, Captain Riddell supervises the account branch of this office and of the whole of the Topographical Surveys, and also the preparation of the monthly and annual statements of expenditure of the entire Department. The adjustment of the accounts of the Survey Officers in Afghanistan, both personal and official, has been greatly facilitated by his voluntarily undertaking various transactions in behalf of these officers without which their accounts, left to be adjusted in the ordinary routine, would probably

PERSONNEL.

Captain R. V. Riddell, R. E., Deputy Superintendent, 2nd grade, and Assistant Surveyor General.
Captain E. H. Steel, S. C., Assistant Superintendent, 2nd grade, and Officiating Assistant Surveyor General.
H. Duhun, Esq., Surveyor, 1st grade, Personal Assistant to Surveyor General.

Drawing Branch.

Mr. J. F. Baness, Chief Draftsman.

Drawing and Compiling.

Mr. J. Peyton, Surveyor, 1st grade.
„ F. Adams „ 3rd „
„ W. Green Draftsman.
„ J. R. Adels Ditto.
„ G. B. Korper Ditto.
Munshi Sunaullah Ditto.
„ Nabibaks Ditto.
Mr. H. J. Musgrove, Apprentice Ditto.
„ W. P. Smith Ditto.
and 15 Native Draftsmen and colourists.

Examining, Computing, and Projecting.

Mr. A. Chamarett, Surveyor, 1st grade.
„ A. J. Wilson „ 3rd „
„ R. D. Farrell „ 3rd „
„ C. A. R. Scanlan „ 4th „
„ C. Tapsell, Assistant Surveyor, 1st grade,
and 2 Natives.

Keeper of original maps.

Mr. R. A. Gibson, Assistant Surveyor, 3rd grade.
Baboo Mohesh Chunder Shah.
Mr. J. A. Higgs.

Engraving Branch.

Mr. C. W. Coard, Superintendent.

Hill-etching.

Mr. W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell.
„ A. G. Palmer.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett.
Munshi Amanatoollah.
Baboo Joy Kristo Shaw and 3Natives.

Outline and Writing.

Mr. J. Fulford,
and 10 Native Engravers.
Mr. O. Tarrant (resigned, 22nd March).
„ E. C. Ollenbach,
and 9 Native Engravers.

Printing.

Mr. T. B. Roger, Writing Engraver and Printer,
and 11 Natives.

Writer.

Baboo Kanny Lall Sen.

Correspondence Branch.

Mr. A. E. Byrn, Registrar.

Recording and Indexing.

Mr. M. Francis.
„ T. E. Ware.
Baboo Banee Madhub Banerjee,
and 1 Native.

Examining and Copying.

Mr. F. A. D'Rozario.
„ J. A. Vallis,
and 4 Natives.

Despatchers.

Baboo Bheecum Singh and one other.

Accounts, Library, and Miscellaneous.

Mr. N. A. Belletty, Surveyor, 1st grade.
„ D. Byrns, Clerk (on leave), Mr. E. D. Algar, Officiating,
and 2 Natives.

Map Issue and Stock.

Mr. T. W. Babonau, Map Curator.
„ H. R. Vallis.
„ W. P. Abro,
and 2 Natives.

become much involved and indefinitely delayed. Captain Riddell's labours have been very varied and onerous and his services most valuable.

320. Captain Steel officiated throughout the year for Mr. J. O. N., James, in the charge of the drawing and examination offices, the engraving office, and the offices of map record and issue. He has done much towards improving the general organisation, and the mutual relations and interaction of these offices, and also in reducing to written rule various matters which had previously been left very much to the discretion of individuals, but not always with satisfactory results. He has also suggested and commenced the arrangement of all the numerous original maps and records, which have been collected during many years in this office, on an improved system, which will facilitate reference to any document that may be wanted, and tend at the same time to keep them all in better preservation. The new arrangement, though highly satisfactory in every respect, is a laborious undertaking which will take some time, probably two years, to complete.

321. The work performed in the drawing office during the past year was of the usual kind, *viz.*, compilations on various scales and from various materials for provincial and other maps; reductions from departmental surveys for the sheets of the Indian atlas and other geographical maps of a final character; copying maps, charts, and plans for Government offices; colouring published maps for issue. The total out-turn of work is large, and there has been a constant aim at improvement, both in the finish and the accuracy of the mapping, by the introduction of a better division of labour and a more systematic procedure, and by making the examining office wholly independent of the drawing office.

322. Little new work, in the shape of fresh compilations, has been undertaken, but considerable progress has been made towards the completion of those which were in hand last year. Of the map of India, scale 1-inch=32 miles, sheets I, IV, V, and VI have been completed in outline, and for sheet III some fresh materials have been supplied from recent surveys. Some of these sheets will soon be transferred to stone and the hills drawn in with chalk for a preliminary issue. The maps of Bengal, the Central Provinces, and the Central India Agency—all on the scale of 1-inch=16 miles—are complete in outline and the hill drawing for the two last is in progress. The maps of the Rajputana Agency and Punjab, on the same scale, have been fairly advanced. Heavy additions, from recent surveys, have been made to a large number of the sheets of the Indian atlas, and twelve new sheets have been commenced. Revised editions of several standard sheets of the Ganjam and Orissa Survey, Central Provinces and Vizagapatam Agency Survey, Hyderabad Survey, and the Khasi-Garo and Naga Hills Survey, have been prepared, and a large amount of miscellaneous mapping has been completed, the details of which will be found in the usual tabular statement given in the appendix.

323. Considerable relief has been afforded to the drawing branch by the transfer to the executive parties of the reductions for the sheets of the Indian Atlas of their own survey work, as it progresses from year to year. The work of reduction had for some time past been wholly performed in this office, often by inferior native agency; but it is now undertaken, whenever possible, by the surveyors themselves, as their knowledge of the ground should enable them to furnish a more perfect and accurate drawing for the engravers than could otherwise be obtained.

324. Brush-shading for hill work had gradually been falling into disuse in this office, owing to the introduction of pen-and-ink drawing to meet the requirements of photozincography. But it has been found that the engravers cannot reproduce pen-and-ink drawing, which is deficient in middle tones, as satisfactory as brush shading, in which variations of tone may be given with great effect. Measures have therefore been adopted to secure good and effect-

Messrs. Francis, D'Rozario, and Baboos Banee Madhub Bannerjee and Bheecum Singh in the Corresponding Branch, have discharged their duties satisfactorily.

ive brush-shaded copies for the hill etchers by transferring Mr. James Peyton, a trained Topographical Surveyor and highly artistic draftsman, from the Kumaon and Garhwal Survey, recently completed, to this office, to undertake and train others to execute the brush shading.*

325. The *Examining Branch* has done much good work in detecting errors in the fair mapping rendered by the executives, checking the work of the drawing branch, furnishing data, examining proofs of maps, charts and plans, and has taken a fair share in the compilation and drawing of general maps and atlas sheets when not otherwise engaged. The final sections of the alphabetical lists of latitudes and longitudes for the Imperial Gazetteer have also been completed and forwarded to Dr. Hunter.†

326. *Engraving Office.*—The precautions taken last year to expedite progress with the engraving of the smaller scale general maps and compilations have been fairly successful, and most of those in hand, *viz.*, India map, 32 miles=1 inch; Bengal, 16 miles=1 inch; Rajputana Agency, 16 miles=1 inch, have been well advanced; and in addition, maps of the Central Provinces and the Central India Agency, on the scale of 16 miles=1 inch, have been commenced and good progress made with the outlines. Four new plates of the Atlas of India, *viz.*, Qrs. 35 N.-E; 90 S.-W; 91 S.-W; and 93 N.-W., have been completed and published; 31 new quarter plates are in various stages of progress; large additions have been made to 11 plates, and repairs to the writing and hills of 18 of the old full size (double elephant) plates, are in hand.

Reckoned in square inches, the total out-turn is as follows:—

	Square miles.
New work, outline and writing . .	4,894
Ditto, hills and sand . .	1,187
Repairs of old work { outline and writing .	4,903
Repairs of old work { hills and sand .	1,457

This method of estimating the out-turn of work, though useful for some purposes, does not convey a sufficiently precise idea of the quantity of the work executed, which can only be acquired from full details of the number of letters, the amount of outlining, and the kind of hill-etching in each square inch of completed engraving. Endeavours are now being made to classify the different descriptions of work, and to assign to each a value in time. A history of each engraved plate in all its stages is now being kept up, in accordance with a suggestion by Captain Steel.

327. The difficulty of obtaining satisfactory transfers to stone, at all times, from engraved copper plates, and more especially from those which had become worn by frequent printing, had caused serious embarrassment as stated in paragraph 127 of the last Report. This has led to a re-trial of the process of steel-facing copper plates, which is very successfully practised in England and protects the surface of the plate and retards the wearing out of the engraving. It was originally introduced in this office in 1872-73‡ but was not utilised to any extent, and in fact was pronounced a failure; fortunately, however, the apparatus and appliances were preserved, and are now being turned to good practical use.

‡ *Vide* General Report on the Topographical Surveys of India and Surveyor General's Department for season 1872-73, paragraph 43, page 6.

328. Details of all the work completed and in progress in the engraving branch are given in the appendix. §

329. The map-issue section of the office has been working under much pressure during the year, because of the great demand for maps for the Afghan

* Captain Steel reports that Mr. Peyton deserves much credit for his work, the hill shading having much improved through his instrumentality. Also that Mr. Adams has brought a very difficult piece of work in the drawing of the Ganjam and Orissa Survey sheets, to a satisfactory close. Mr. Green is also favourably reported.

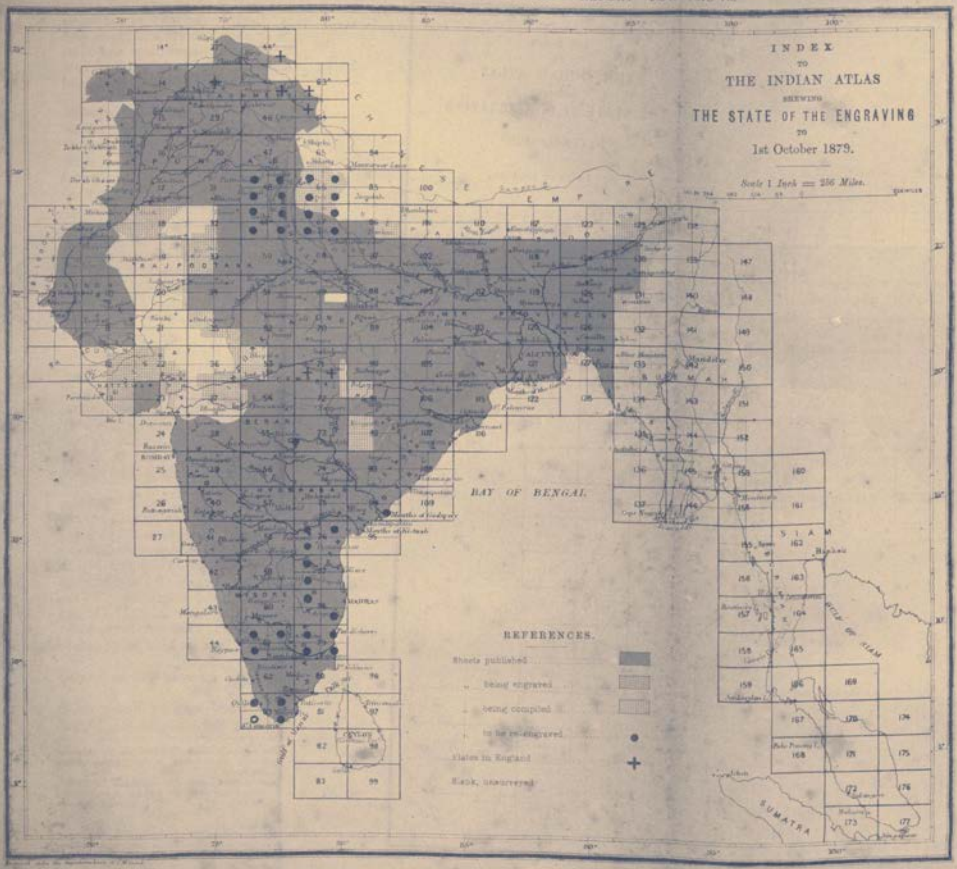
† Captain Steel reports that he is much pleased with the steady work of Mr. Chamarett, and that the check which he has kept on the Drawing Branch has been most beneficial; that Mr. Wilson has shewn an amount of method and ability which is very promising; that Mr. Gibson deserves special commendation * * * and that Mohesh Chunder Shaw has given much satisfaction.

§ Captain Steel reports as follows on the work of the engraving branch:—

"The hill-etching has received my careful attention, and I think the work of the hill-etchers deserves much commendation. There has been a steady determination not to sacrifice quality to quantity, and the result is satisfactory. All the three apprentices in this section are doing well and are all employed on Atlas Sheets. The native etchers have been employed on the repairs of hill work, which they have executed well and skilfully.

"The outlines and writing have improved; the former is not so stiff, and in the latter work the native engravers have made a great stride; most of them are now capable of drawing in and spacing their own work, under, of course, European supervision, and they are beginning to take a much keener interest in it" * * * "All have worked well and willingly. Mr. Coard has rendered very efficient help. The work of Mr. Palmer merits much commendation. I am especially pleased with the great pains which Mr. Donaldson has taken with the 32 mile-1 Inch map of India. Mr. Coard, junior, has worked well and given much care and attention to the printing work."

ACCOMPANIMENT TO SURVEYOR GENERAL'S REPORT FOR 1878-79.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India
Surveyor General's Office, Calcutta, December 1879.

War. Upwards of 1,400 despatches were made, some of them of several hundred sheets each, by post, rail or steamer, involving the preparation and despatch of a corresponding number of invoices, and receipts for signature and return to this office.

330. Applications for maps frequently necessitate much correspondence, especially those from private individuals, who are often unable to specify their requirements otherwise than in a very general way. It has been found, too that the aid afforded by the established map agents has not been as considerable as had been expected; the agents do not keep up a sufficient stock of the maps in general, but only of those which are most largely in demand; thus in a number of cases they merely apply to this office for a single copy of a map instead of for a sufficient supply to obviate the necessity for frequent demands on the office. During the year, 1,600 letters, indents, and telegrams for maps were received, and about 1,412 letters were issued, either in reply, or as advice of despatch, exclusive of the invoices. A stock book shewing the numbers of every map received and issued, and a register, or diary, of daily despatches, are kept up, besides the stock account with the different agents.

331. In consequence of the additional business caused by these and other applications for the purchase of single maps, an agency has been opened in the office to attend to all such requisitions. The Agent, Mr. J. N. T. Wood, is paid by the usual trade commission on sales effected. Tradesmen applying for less than 10 copies of any map are required to pay for them in cash, without discount; when taking 10 or more copies they receive the usual agency commission.

332. The map issues have been as follows:—

	Maps.	Value. Rs.	A.	P.
To Government officials . . .	23,497	30,903	7	0
„ India Office . . .	1,780	2,462	8	0
„ agents for sale . . .	2,090	2,746	8	0
„ cash sale by Mr. Wood . .	1,370	2,161	9	0
Total .	28,737	38,274	0	0

333. Besides the above, the work connected with the colouring of printed maps for sale and issue, which is entirely done by colourists paid at contract rates, is performed by the map issue branch. 15,616 sheets were coloured. Pass books are kept up for each colourist and their accounts are settled weekly.*

(2) The Revenue Survey Office.

334. A general return of the out-turn and cost of the several parties of the Revenue Branch is given at page 77. The principal records prepared by executive officers are shown in statement A, at page 68 in the appendix, followed by statements (B and C) of the work performed by the head office, at pages 69 to 73.

Personnel.

Lieutenant-Colonel J. Sconce, Deputy Surveyor General, and Superintendent Revenue Branch.
Major F. Coddington, Deputy Superintendent, 2nd Grade.

Drawing Branch.

Mr F. W. Kelly, Surveyor and Head Draftsman.

Drawing and Compiling.

Mr. J. Connor, Assistant Surveyor and Draftsman.
Sheikh Abdul Aziz, Draftsman.
„ Rohim Bux, „
„ Golam Mahomed, „
4 others, and 8 colourists.

Map examining.

Mr. J. A May, Surveyor and Draftsman.
„ T. W. Reilly, „ „
Sheikh Abdul Razak „ „
„ Wahed Bux „ „

Computing and record examining.

Baboo Hari Har Sein, Computer.
„ Tin Cowry Sein „ and 2 others.

Cadastral map and proof examining.

Mr. W. Sinclair, Surveyor and Draftsman.
Sheikh Mehir Ally and 6 other draftsmen.

Correspondence and Accounts Branch.

Mr. J. P. Adels, Registrar.
„ A. C. Cunningham, 1st Assistant.
Baboo Gopal Chunder Laha, Accountant.
„ Kally Pudo Banerjee, 2nd Assistant and Reference Clerk.
Baboo Doorga Narain Ghose, Clerk.
„ Ramkisto Chunder and 8 other clerks.

Despatcher.

Baboo Judo Nath Mookerji.

Record and map issue Branch.

Mr. W. J. Lane, Assistant Surveyor.
Baboo Asbootosh Kur, and 1 other.

* Captain Steel reports that the Map Curator, "Mr. T. W. Babonna, has worked his section very systematically; he is a good man of business, careful and painstaking; he is also resourceful."

"The appointment of Mr. Wood in this office as a private agent has been a success. Mr. H. R. Vallis has given satisfaction."

Captain Steel reports as regards Mr. Gibson's work of re-arranging the original maps, that a good deal has been done towards the cataloguing. Section I of the catalogue, comprising the triangulation charts of India, in number 500, in 755 sections; and II, the Atlas of India, 213 plates in 1,320 sheets, have been completed. Section III, maps of India, river and railway maps, is in hand; 152 maps in 346 sections have been finished.

Mapping.

335. The original mapping done in the office of the Deputy Surveyor General, is chiefly in connection with the publication of general maps on the scale of 1 inch=1 mile; the drawing is partly done on the scale of 2 inches for reduction to the final scale by photography, and partly on the 1-inch scale for direct reproduction. The following maps, which, with the exception of the sheets of Lakhimpur and Monghyr, are of the standard size of 30′ longitude × 15′ latitude, have been drawn and sent to press during the year, *viz.*,—

Lakhimpur district, 2 sheets.
Maldah district, ... 8 sheets (revised edition).
Monghyr district, ... 6 sheets ditto.
Deccan Topographical Surveys ... 5 sheets (additions made to original sheets of topography of Nizam's dominions).

In addition to which the following sheets, each drawn in four 2-inch sections in the offices of the field parties, have been examined and submitted for publication, *viz.*, Deccan Topographical Surveys, 4 sheets. Besides the maps which have been actually sent to press, eighty-eight 2-inch sections and one 1-inch sheet drawn in the Calcutta Office, and twenty-four 2-inch sections and twenty 1-inch sheets drawn in the offices of field parties, are ready and only await final examination.

336. The disposal of the maps of the cadastral surveys is now the largest operation undertaken by this office; every field limit and every field number require close scrutiny before the maps can be sent to press, and the same examination is necessary for the printed proofs before giving the final press order. In this manner 4,511 maps and 4,715 proofs have been examined during the year.

Publication of cadastral maps.

337. The publication of cadastral maps has been carried on chiefly at the Photographic Branch of the Surveyor-General's Office, though some work has been done at the Government Press at Allahabad and a little by private firms in Calcutta. The total number of maps published during the year at all establishments is 5,321. For the future, it is intended that the entire publication shall be carried out in the Surveyor-General's Office, partly by photozincography and partly by lithography. The publication of the maps of the irrigation tracts in the Cuttack District has been undertaken in the office of the Secretary to the Government of Bengal, Public Works Department.

The following is the state of publication on 31st December 1879 :—

State of Publication of Cadastral Maps on 31st December 1879.

Districts.	Number of sheets: Surveyed. Up to 31st December 1878.	Surveyed. Added during 1879.	Surveyed. Total up to 31st December 1879.	Published. Up to 31st December 1878.	Published. During 1879. By Surveyor General's Office.	By Calcutta firms.	By Allahabad Press.	Published. Total up to 31st December 1879.	Remaining to be published.
N.-W. Provinces.									
Agra	(a) 2,925	...	(a) 2,925	(a) 918	1,932	44	...	(a) 2,894	31
Azamgarh	930	...	930	930	...	...	...	930	...
Banda	2,632	722	3,354	1,018	383	192	365	1,958	1,396
Ghazipur	...	245	245	...	245	...	...	245	...
Hamirpur	(a) 2,926	...	(a) 2,926	(a) 2,620	297	...	...	2,922	...
Jaunpur	270	784	1,054	...	1,036	...	...	1,036	18
Moradabad and Terai	(a) 4,023	...	(a) 4,023	(a) 3,034	...	...	89	4,023	...
Muttra	(a) 1,658	...	(a) 1,658	1,218	145	117	178	1,658	...
Total	(a) 15,364	1,751	17,115	(a) 10,647	4,038	353	632	15,670	1,445
Bengal.									
Patna and Gya	(a) 3,054	...	(a) 3,054	2,956	90	8	...	3,054	...
Shahabad	(a) 4,924	...	(a) 4,924	4,724	25	175	...	4,924	...
Pooree (Khorda Estate)	1,939	1,420	3,359	...	...	...	...	...	3,359
Total	(a) 9,917	1,420	11,337	7,680	115	183	...	7,978	3,359
Grand Total, North-Western Provinces and Bengal	(a) 25,281	3,171	28,452	(a) 18,327	4,153	536	632	23,648	4,804

(a).—Figures of last return have been altered to agree with the final arrangement of sheets.
NOTE.—The publication of the cadastral maps of the Cuttack Irrigation Tracts has been undertaken in the office of the Secretary to the Government of Bengal, Public Works Department.

Miscellaneous duties of Drawing Branch.

338. The time of the office is largely occupied in examining the maps received from field parties, and this examination has to be specially attended to in the case of maps to be submitted for direct publication by photography. The systematic examination of the traverses and other records of six survey parties has been carried out, and the errors and omissions which have been noticed have been communicated to executive officers for future guidance; as a rule, the records were found to have been carefully prepared. The areas of the Agra, Baraich, and Midnapur Districts have been revised in accordance with alterations in boundaries subsequent to the time of survey. Many demands have been made for copiesof maps and records that have not been published; the requirements of Government officials are executed as part of the office work; for other applicants, copies have been supplied on payment as extra work done out of office hours.

339. The record-rooms of the office have been rearranged and a new register is under preparation, which, it is intended, shall eventually be published in the form of a catalogue. The want of systematic arrangement and of a complete list of the records had long been felt, but neither could be undertaken by the regular establishment for want of time. Captain D. C. Andrew was employed on this work during the time between his return from furlough and until he was required to proceed to Burma, and the present state of order is mainly due to his exertions.

Correspondence Branch.

340. The checking of the pay bills and the passing of the bills for travelling allowances and for contingencies form a large part of the duties of the Correspondence Branch of the office. This branch has also had much to do during the past year in tracing the services of several members of field parties who had been recommended for pensions and gratuities.

341. The Deputy Surveyor General heartily acknowledges the very great assistance he has received from Major F. Coddington in all matters connected with the management of his office and with the control of the Revenue Survey field parties.*

(3) Lithographic Office.

342. The most important publications which have been issued during the year from this office are as follows:—

Personnel.

Captain R. V. Riddell, R. E., in charge.
Mr. E. Jevezy, Head Assistant and Chief Draftsman.
Mr. H. Lepage . . . .
„ J. Musgrove . . . .
Baboo Buloram Nath . . . . } Draftsmen.
Mahomed Azeem . . . .
Sobhan Buksh and 26 others . .
Mr. H. Niven, Chromo-Litho. Printer.
„ E. DePyvah, Printer.
1 Press assistant and 20 others.
3 Native Clerks.

District Rajshahie, „ Furreedpore — Scale 1-inch=1 mile in 24 sheets, measuring 40″ × 25″

District Bahraitch, „ Purneah — Scale 1-inch=4 miles obtained by transfers from the copper-plates of the sheets of the Indian Atlas with corrections on stone for the internal sub-divisions and external boundaries, lines of new roads, railways, canals, &c.

General Maps.

343. *Atlas of India,* scale 1 inch=4 miles. The sheets specified in the margin were obtained by transfers from the copper plates and coloured by stone printing.

Full size (double elephant) sheets, Nos. 68, 102, 103, 104, 107, 111, 112 and 121.
Quarter sheets Nos. 5 N.-E., 34 N.-W., 35 N.-E., 87 N.-W., 91 N.-W., 92 S. E.; and 93 S.-E.

Geological map of the Salt Range, Punjab, in 2 sheets, scale 1 inch=4 miles, printed in seven colours, which entailed 10,104 pulls.

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* Mr. F. W. Kelly, Surveyor and Head Assistant, Drawing Branch, has rendered excellent service; his long experience in the office is of much value.

Messrs. W. Sinclair, J. A. May, T. W. Reilly, J. Connor, and W. J. Lane, Surveyors and Draftsmen, have all done good work in their own branches of the office.

Mr. J. P. Adels, Registrar of the Correspondence Branch, Mr. A. C. Cunningham, 1st Assistant; Mr. Gopal Chunder Laha, Accountant; Baboo Kallypudo Banerjee, 2nd Assistant and Reference Clerk, and Baboo Haribar Sein, Head Computer, have given much satisfaction. The other clerks, draftsmen, and computers have all done well.

Mr. J. P. Adels, Registrar, retires on the 1st January 1880 on a good service pension, after a long career in various Government offices, of which the last 16 years and 9 months have been in the office of the Deputy Surveyor General.

District Sealkote, scale 1 inch=2 miles, for the Punjab Government.

Fyzabad and Rae Bareli Divisions, scale 1 inch=4 miles, for Government, North-West Provinces and Oudh, Public Works Department.

Sheet 4 of the *General map of Assam*, scale 1 inch=4 miles, has been printed. Sheets 3 and 5 are in proof.

344. A large number of maps of various kinds are in different stages of progress, and work to the value of Rs. 18,798 has been completed and printed for other departments of the State, for all of which full details are given in Captain Riddell's report in the appendix.

(4) The Photographic Office.

Personnel.

Captain J. Waterhouse, B.S.C., Assistant Surveyor General, in charge.

Negative Branch.

Mr J. Mackenzie, Photographer.
" C Marshall, ditto.
" L. Lagnier, ditto.
" G. G. Dempster, ditto.
" T. Lloyd, ditto,
and 11 subordinate assistants.

Photographic Transfer Branch.

Mr. J. Harrold, Photographer.
" R. George, ditto,
and 2 subordinate assistants.

Silver Printing Branch.

Umbica Churn Bhuttacharjee, Assistant Photographer, and 1 assistant.

Zinc Printing Branch.

Mr. R. Mackenzie, Zincographer.
" J. Watson, ditto (on furlough.)
" E. A. Lefranc, ditto,
and 13 Native zinc correctors, 12 zinc printers, 9 zinc grainers, and 34 pressmen.

Store and Office Branch.

Mr. A. E. Caddy, store-keeper and general assistant.

Syud Ishmael, Head Clerk and Accountant, and 4 Native clerks.

345. The details of the work executed during the year are shewn in the following table:—

Abstract of work performed in the Surveyor General's Office, Photographic Branch, from 1st October 1878 to 30th September 1879.

	Sections or sheets.	Negative plates.	Photographic transfer prints.	Transfer to zinc or stone.	Number of pulls.	Number of printed sheets of each subject. Single.	Number of printed sheets of each subject. Combined.		Remarks.
Topographical maps	92	193	136	31	3,784	4,609	4,609		
Revenue Survey "	105	122	112	48	10,600	6,680	6,680		
District maps	7	21	29	5	800	800	709		
General "	9	14	8	48	8,512	5,772	6,122		
City and Cantonment plans	34	57	57	16	1,560	1,135	1,230		
Miscellaneous department	216	372	289	180	16,284	19,789	18,470		
Ditto extra department	346	513	549	318	49,894	85,277	75,723		
Proofs	...	...	...	...	3,159	..	...		
Silver prints	...	...	..	...	...	...	...	192	
Pigment "	...	...	...	...	...	...	...	245	
Platinum "	...	...	...	...	...	...	...	26	
Cadastral, Bengal	411	...	...	411	20,550	20,550	12,800		Transfer traces, 411 sheets.
Total	1,222	1,322	1,180	1,064	1 15,173	1,44,912	1,26,334		
Cadastral, North-West Provinces	3,941	3,401	3,359	4,162	1,03,150	1,03,150	56,125		Transfer traces, 704 cet s.
Grand Total	5,163	4,723	4,539	5,226	2,18,323	2,48,062	1,82,459		

346. The work of reproducing the cadastral maps of the North-West Provinces has progressed satisfactorily, the number of sheets printed off during the year being 4,126, or 566 more than last year. Since May, the supply of this work has somewhat diminished, and it is not likely in future to exceed 3,000 sheets yearly—an amount the cameras are more than capable of dealing with—so that the work of reproduction will proceed almost *pari passu* with the surveys, or at any rate as fast as the sheets can be received.

347. Four hundred and eleven sheets of the cadastral maps of Bengal, on the scale of 32 inches to the mile, were printed off from tracings for the Irrigation Department, but since April this work has stopped and appears unlikely to be resumed.

348. A few improvements have been made in the processes, as the result of Major Waterhouse's visit to Europe last year. The principal are, the introduction of the platinotype process and of a simple pigment printing process, the details of which will be found in the Appendix.

349. Major Waterhouse has given a good deal of attention to the photo-electrotype process, but has not been able to make much progress owing to difficulties experienced with the pigment tissues and with the electrotyping; he proposes to devote part of the furlough which he has recently obtained to learning the process practically in Europe, if opportunity offers.

350. A large amount of work has been done for other departments, as shewn in the statement attached to Major Waterhouse's report in the Appendix. The principal items are several maps, plans, and sketches, illustrative of the campaign in Afghanistan, reproduced for the Quarter Master General's Departments; 63 drawings and plans of barracks, &c., for the Military Works Department; 18 charts for the Marine Department and Port Office.*

(5) The Mathematical Instrument Office.

351. The last annual report of the Survey Department was the first which gave an account of the year's operations of the Mathematical Instrument Office. The business of that office has almost from the first been conducted under the orders of the Surveyor General, and usually under the immediate supervision of one of the Survey Officers residing in Calcutta; but the greater portion of its work was performed for other departments than the Survey, which is probably the reason why its operations have not been noticed, otherwise than very cursorily, in the reports of the Survey Department.

352. A full account of the general business of the office, and of the factory which is attached to it, was given in the last report. Here, therefore, it is only necessary to give a résumé of the year's proceedings, shewing, in accordance with recent instructions, "what departments have been supplied with instruments, to what extent and of what class; how the supplies have been obtained, *i. e.*, whether by local manufacture or purchase, or from England, or by inter-departmental interchange; the relative cost of each method and the general out-turn of the Depôt compared with its expenditure."

353. During the year 1878-79, instruments of various kinds to the value of about Rs. 34,500 were obtained from England: about 1,700 were purchased in the local market at a cost of Rs. 7,500. A number of the commoner class of instruments, to the value of about Rs. 10,000, were manufactured in the department. Over 6,700 instruments, in value nearly Rs. 54,000, were received by inter-departmental interchange, of which over 1,000 were repaired in the department at a cost of about Rs. 22,000.

Personnel.

Captain R. V. Riddell, R. E., Superintendent. Mathematical Instrument Department.

Workshop Branch.

Mr. R. Wehlisch, Mathematical Instrument Maker, on furlough.
Mr. T Bolton, Officiating Mathematical Instrument Maker.
Mr. J. Antram, Assistant Mathematical Instrument Maker, from 1st April 1878 to 14th September 1878.
Mr. W. H. Burns, Officiating Assistant Mathematical Instrument Maker, from 14th October 1878 to 31st January 1879.
66 Permanent Artificers and about 80 Temporary Artificers on an average.

Store Branch.

Mr G. R. Alderman, Store keeper.
Babu Woomesh Chunder Chowdry, Packing Sircar.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ M. J. O'Brien, Assistant Clerk, from 1st April 1878 to 16th October 1878.
Mr. J. W. Collins, Assistant Clerk, from 1st November 1878 to 31st March 1879.
6 other Permanent Clerks and 2 Extra Clerks.

354. More than 18,000 instruments, in value nearly Rs. 1,28,000, were issued from the Depôt during the year, *viz.* :—

	Approximate Number.	Approximate Value. Rs.
To the Survey Department	7,470	51,000
„ Marine „	100	1,900
„ Telegraph „	10	200
„ Military Department, Bengal	860	9,000
„ Public Works Department	6,340	36,100
„ Educational Department	43	930
„ Miscellaneous Departments	2,842	22,670
„ Road Cess Committees, District Engineers, &c., not entitled to receive instruments on indent, on book debit	280	3,700
To Workshop to complete repairs of instruments	470	1,300
	18,410	1,27,800

* Major Waterhouse reports very favourably of Messrs. J. Mackenzie, B. Mackenzie, J. Harrold, and Mr. Caddy; he also commends Syud Ismael and Messrs. Marshall, Lagnier, George, Lefranc, and Dempster.

355. The principal instruments issued are:—

To the Survey Department.—Aneroid barometers, binoculars, chains, magnetic compasses, drawing instruments, heliotropes, reading lenses, plane tables, planimeters, protractors, flat rules, scales of various sorts, optical squares, telescopes and theodolites.

To the Marine Department.—Barometers, binoculars, Massey's patent logs, carpenter's rules, drawing instruments, sympiesometers, telescopes, and thermometers (but all in very small number).

To the Military Department.—Pocket aneroid barometers, sketching cases, prismatic compasses, drawing instruments, reflecting levels, protractors, scales of various sorts, pocket sextants and tapes.

To the Public Works Department.—Drawing boards, chains, compasses, curves, drawing instruments, levels, protractors, Carpenter's rules, flat rules, scales of various sorts, leveling staves, tapes and theodolites.

To Miscellaneous Departments, viz., Meteorological Department, Telegraph Department, Educational Department, and others.—Aneroid barometers, chains, drawing instruments, prismatic compasses, surveying compasses, protractors, flat rules, scales of various sorts, pocket sextants, tapes, thermometers and wind vanes.

356. The rates at which instruments were locally purchased were on an average about 34½ per cent. higher than those at which the instruments received from England have been issued to the public service or placed in stock for future issue, and which are 20 per cent. above their English prices, in order to cover freight and other charges. The comparison is, however, even more in favour of the supplies from England than these figures represent; for the articles purchased in the local market are seldom equal in quality to those received from England.

Statement shewing the excess of Calcutta prices over values at which Instruments procured from England are issued, and rate per cent. of the excess.

Names of Instruments.	No. of instruments purchased.	Issue value of corresponding instruments obtained from England.	Amount paid in Calcutta.	Excess of Calcutta prices over issue values.	Rate per cent. of excess.
		Rs. As. P.	Rs. A. P.	Rs. A. P.	
Chronographs	1	50 0 0	75 0 0	25 0 0	50
Compass, magnetic, pocket, in brass case	1	15 8 0	28 0 0	4 8 0	29
,, Napier's	23	494 8 0	649 4 0	154 12 0	31
Hour glasses	18	24 12 0	36 0 0	11 4 0	44
Instruments, drawing, electrum	38	1,865 0 0	2,482 0 0	617 0 0	33
Lamps, bull's eye	9	40 8 0	50 12 0	10 4 0	25
Lenses, reading	13	21 12 0	30 8 0	8 12 0	36
Levels, reflecting	1	27 0 0	40 0 0	13 0 0	48
Meters, current	1	55 8 0	70 0 0	14 8 0	26
Pens, drawing, dotting	6	42 0 0	57 0 0	15 0 0	35
Pins for maps	1,363	75 0 0	108 0 0	33 0 0	41
Protractors	48	295 2 0	427 2 0	132 0 0	45
Scales, marquois, sets, wooden	1	10 0 0	11 4 0	1 4 0	12
,, offsets, single ,,	6	3 0 0	4 8 0	1 8 0	50
Sextants, pocket	3	186 0 0	260 0 0	74 0 0	39
Sundials, portable	3	112 8 0	158 0 0	45 8 0	40
Tapes, measuring, metallic, 50'	25	100 0 0	125 0 0	25 0 0	25
Thermometers, spare, for hypsometers	6	75 0 0	90 0 0	15 0 0	20

Statement shewing the Principal Instruments manufactured in the Workshops and the savings effected thereby.

Names of Instruments.	Number manufactured.	Cost of manufacture in the Mathematical Instrument Workshop.	Value at which the instruments would have been issued if obtained from England.
		Rs. A. P.	Rs. A. P.
Boards, drawing	28	189 14 0	239 0 0
Chains	322	1,956 1 0	2,302 8 0
Pluviometers	20	112 14 0	191 0 0
Scales, plotting, brass, with offsets	12	63 11 0	126 0 0
Squares, wooden, single	15	19 11 0	67 8 0
Stands for instruments	52	453 11 0	676 0 0
TOTAL		2,805 14 0	4,301 0 0
Cost of manufacture in the Department		.....	2,805 14 0
Difference, savings effected		.....	1,495 2 0

357. The Departmental manufactures, in value of about Rs. 10,000, consisting chiefly of chains, hand map-printing machines, drawing boards, plane tables, pluviometers, stands for compasses, plane-table telescopes, &c., and packing cases (as far as information exists from which a comparison can be made), are issued at about two-thirds of the value at which similar articles could be issued if procured from England. The savings shewn to be effected by the Departmental manufacture of these is about Rs. 1,500. This is no very large amount; but the manufacture of new articles is not the

chief object of the workshops, about twice as much work being done in repairing as in manufacturing.

358. The cost of the portion of the establishment which was employed in the construction and repair of these instruments, the cost of materials expended, the share of office accommodation, the estimated loss by wear and tear of block, and other contingencies—in all about Rs. 36,000—is practically identical with the value of work done, as represented in the case of instruments manufactured, by the value at which they are issued, and, in the case of instruments repaired, by the difference between the value at which they are issued or placed in store for future issue and that which they held previous to repair. The cost of the remaining portion of the establishment, including share of supervision and office accommodation, was about Rs. 19,000, which may be regarded as the expenditure incurred on the receipt and issue of more than 40,000 instruments,—value over Rs. 2,50,000,—and of storing, about Rs. 38,000 more, with a view of future issue.

359. Considerable progress has been made in the matter of marking and arranging systematically the stock of instruments, the great object being that any one comparatively unacquainted with instruments should be able to find what is wanted. Mr. Bolton has had to devote a considerable portion of his time to that duty, and the store-keeper has worked well and energetically, both giving much of the time which is usually left for Government employés to spend according to their own fancies, to this branch of the work. About four-fifths of the stock has been marked. The amount of work during the year has been well up to the average of many years, as far as the number of instruments received and issued are concerned, and at times has been exceedingly heavy, especially so for some months after the commencement of the Afghanistan Expedition.

360. The repairs of the 24-inch theodolite, referred to in the last Administration Report, appears to have been very successfully accomplished, for Colonel Branfill wrote on the 25th March last on the subject as follows:—(*vide* foot note*).

(6) The Trigonometrical Survey Office.

361. The principal work of this office is the final reduction and publication of the triangulation of all parts of India; and the reproduction of the surveys executed in the Trigonometrical Branch of the Department. The office being located at Dehra Dun, at a considerable distance from Calcutta, has a Drawing Branch, a Photozincographic Branch, and a Printing Branch of its own; it is thus independent of all extraneous assistance in the matter of publication, excepting as regards the binding of its productions, which has to be done elsewhere, usually in Calcutta.

Personnel.

J. B. N. Hennessey, Esq., M.A., F.R.S., Deputy Superintendent, 1st Grade, in charge.
W. H. Cole, Esq., M.A., Assistant Superintendent, 1st Grade.
E. C. Ryall, Esq., Officiating Assistant Superintendent, 2nd Grade.

Computing Branch.

Mr. C. Wood, Surveyor, 2nd Grade.
„ H. W. Peychers, Surveyor, 4th Grade.
Babu Gunga Pershad, Computer.
„ Cally Mohan Ghose, „
„ Kally Coomar Chatterjee, „
and 11 other computers, &c.

Printing Branch.

Mr. M. J. O'Conner, Printer.
16 Compositors and Apprentices.

Correspondence and Stores.

Mr. L. H. Clarke, Surveyor, 2nd Grade, and 2 native writers.

Photozincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
1 Native Apprentice „
2 Native Draftsmen.
1 Native Apprentice Draftsman,
and 1 Map-keeper.

Drawing Branch.

Mr. G. W. E. Atkinson, Surveyor, 3rd Grade.
„ W. Sindon, „
Jafir Khan and 4 other Draftsmen.
1 Assistant Draftsman, and 20 Apprentices and Map Colourists.

Officers doing duty at Head Quarters.

Mr. J. Peyton, Surveyor, 1st Grade.
„ W. Todd, „ 2nd „
„ T. Kinney, Assistant Surveyor, 1st Grade.

Solar Photography.

Mr. M. Meins, Solar Photographer.

* "I have now used the 24^{v} theodolite at 17 stations and observed 2 Azimuths with it, since it was returned to me from the Government Mathematical Instrument Department, Calcutta, and I have now great pleasure in reporting to you and testifying to the thorough and effective manner in which the adjustments have been made.

"The improvement in every particular of which I complained (in my No 260 of 31st May last) is manifest, and I have great satisfaction in using the instrument which last season made the use of it intolerably irksome."

The office has also a depôt of instruments and stores attached to it, chiefly containing the higher class instruments appertaining to the Trigonometrical Survey, of which it has long been the Head-Quarters Office. It is now and has for many years, been under the immediate and able superintendence of Mr. Hennessey, M.A., F.R.S., who is well aided by Mr. Cole, M.A.

362. The year's work has been more varied in nature and laborious than usual, because of the demands arising from the military operations in Afghanistan, for maps from the general public, and for instruments and equipment from the survey officers attached to the several divisions of the army. The sum of Rs. 3,600 was realised by the sale of maps, chiefly of Afghanistan, to private individuals. Full details of all the operations of the office are given in the Appendix.

363. Volumes II, III, and IV of the Account of the Operations of the Great Trigonometrical Survey, one of which was in the hands of the bookbinders on the date of the last Report, have been published, and presentation copies have been supplied to all the leading scientific societies, libraries, and men of science that are likely to be interested in their contents, in all quarters of the globe, but chiefly of course in Europe and America. Of volume V, which gives an account of the pendulum operations, the printing has been completed and the sheets are in the hands of the bookbinders; it should soon, therefore, be available for publication and presentation as in the case of the preceding volumes. Volume VI, the preparation of which has mainly devolved on Mr Cole, is well advanced towards completion, and might, if necessary, be published during 1880; but it will probably be delayed until the completion of volume VII, as the contents of the two volumes are closely allied and their simultaneous publication is desirable. Other volumes of this, the principal or geodetic series, which gives full details of the observations and their reduction, are in hand.

364. Of the Synoptical Volumes—which give a précis of the requisite results, both principal and secondary, for topographical and geographical requirements—the first six were published some years ago; volumes 7 to 11 inclusive have been lately completed and are now in the hands of the bookbinders, and volumes 12 and 13 are well advanced and should be completed in the next year. Other volumes are also in hand. No. 7 contains an interesting introductory account of the Kashmir and N.-W. Himalaya Surveys, which was written by Mr. J. Peyton.

365. When the volume which gives the account of the pendulum operations was approaching completion, Major Herschel, who had been engaged for some time in reducing the observations from the level of the stations at which they had been made to the sea-level, and in various investigations which had for their object the combination of the observations in India with those with other pendulums in other parts of the globe, urged that there was still much to be done towards effecting a general combination of the results of pendulum operations in all parts of the world, and solicited permission to undertake it, proceeding to Europe for the purpose of acquiring the data which the libraries in India do not furnish. His proposals were submitted by the Secretary of State for the opinion of the President and Council of the Royal Society, and having been favourably received, he has been allowed to proceed to Europe on duty for the purpose of carrying them out.

366. In addition to its current duties, the Drawing Branch of the office at Dehra completed the fourth edition of the map of Turkistan. This map was photozincographed on the spot and published in the summer of 1879; it contains all the latest geographical information, obtained up to date, which is capable of being shewn on the scale of 1-inch to 32 miles; as, however, additional information is being constantly received from the surveys now in progress in Afghanistan, a new edition of the southern sheets of this map will soon be needed, and has already been taken in hand. The Photozincographic Branch of the office has this year printed twice as many maps as the average of the preceding four years. The Printing Branch has also been very fully employed.

367. The solar photographs which were being taken at Dehra by Mr. Meins, who had been deputed to India for the purpose by the Secretary of State, were carried on successfully, under the supervision of Mr. Hennessey, until the 31st March, when Mr. Meins died most suddenly and unexpectedly of internal

hæmorrhage. During the 89 days which had elapsed from the 1st January, observations were taken on 79 days, on 57 of which the sun exhibited no features whatever to photograph, on 20 it presented faculæ only, and on 2 days both spots and faculæ; during 10 of the 89 days observations were attempted, but bad weather prevailed and the sun was hidden by clouds. On the death of Mr. Meins the observations were suspended for several months, but they have recently been resumed by Mr. Clarke, Surveyor, 2nd grade, under Mr. Hennessey's superintendence.*

* Mr. Hennessey acknowledges the valuable assistance he has received from Mr. Cole in general co-operation and supervision. He also reports very favourably of the services rendered by Mr. Wood, and Baboos Ganga Pershad and Cally Mohan Ghose in the Computing Office, and by Messrs. Peyton and Kinney in general mapping and other matters; he commends Messrs. Clarke, Todd, Atkinson, and Peychers; praises Messrs. Ollenbach and Dyson for their excellent photozincographs; and says of Mr. Meins, the Solar Photographer, that he was diligent, conscientious, and efficient in the discharge of his duties, and that his sudden death is greatly to be regretted.

Abstract of the Out-turn of Work executed by the TRIGONOMETRICAL PARTIES during the Survey year 1878-79.

Description of Details.	Madras Coast series 24-inch Theodolite.	Western Sind and Beluchistan Vernier Theodolites.	Burma Secondary Triangulation. Vernier Theodolites.	Spirit leveling operations.
Number of principal stations newly fixed	17			
Ditto ditto triangles completed	20			
Lengths of principal series in miles	77			
Area of principal triangulation in square miles	1,121			
Average triangular error in seconds	0″·73			
Ditto probable error of angles in seconds + ...	0·15			
Astronomical azimuths of verification observed	2			
Number of principal stations selected in advance	9			
Lengths of principal approximate series in advance	42			
Number of towers, pillars, and platforms constructed for principal stations	15			
Number of scaffolds erected for principal stations	16			
Ditto principal stations placed under official protection ...	16	.....	12	
Ditto ditto ditto protected and closed	16	.....	10	
Ditto ditto ditto the elements of which have been computed	17	.. ...	34	
Ditto secondary stations fixed	.....	.....	11	
Ditto ditto triangles, of which all three angles have been observed	.....	.....	17	
Ditto ditto ditto of which only two angles have been observed	.....	.....	1	
Lengths of secondary series in miles	... ..	208	48	
Area of secondary triangulation in square miles	766	2,010	520	
Do. embraced by triangulation to prominent points, hill peaks, &c., in square mile	.....	7,000	650	
Number of points fixed by intersection, but not visited	40	135	22	
Ditto stations and points, the heights of which have been determined	38	189	28	
Ditto pillars, platforms, or posts for secondary stations, constructed or repaired	.....	49	9	
Ditto miles of rays cleared	50	74½	129	
Ditto do. pathway cleared	.....	3	4	
Ditto hill tops cleared of forest and jungle	... ..	.....	8	
Ditto secondary stations, the elements of which have been computed	.....	39	.....	
Ditto miles leveled over	.....	.....	.....	396
Ditto permanent bench-marks fixed	.....	.....	.....	389
Ditto preliminary charts of triangulation	1	.....	1	

Summary of results of the work of the TOPOGRAPHICAL

TRIANGULATION.

Scale of Survey.	Topographical Survey.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	1st class, or those in which each angle is usually observed on four zeros or more.					2nd class, or those in which each angle is usually observed on two zeros.					3rd class, Tertiary, or those in which two angles only of each triangle are observed.				Number of extra heights determined by barometrical observations or otherwise.
						Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	
½ inch = 1 mile.	No. 7 Party, Rajputana ...	9,860	151	8·2	16·9	...	...	...	...	...	127	270	7·2	·28	139	1,071	1,774	1·3	444	...
		9,860	151	8·2	16·9	...	...	...	...	...	127	279	...	...	139	1,071	1,774	...	444	...
1 inch = 1 mile.	No. 1 Party, Gwalior and Central India	1,668	46	8·1	12·8	...	...	...	...	...	32	85	5·1	·198	30	185	332	0·32	107	...
	No. 5 Party, Bhopal and Malwa	1,720	44	5·0	7·3	...	...	...	...	...	34	70	3·9	·083	34	310	629	1·9	202	...
	No. 8 Party, Mysore ...	4,850	85	5·1	8·3	...	...	...	...	...	56	227	7·0	·24	66	829	1,668	0·95	512	3,486
		8,238	175	5·7	8·7	...	...	...	...	...	122	382	...	...	130	1,324	2,629	...	821	3,486
2 inches = 1 mile.	No. 2 Party, Khandesh and Bombay Native States	643	40	3·5	4·3	...	...	...	...	...	33	72	9·9	·62	33	151	268	1·28	116	...
	No. 6 Party, Garo, Khasi, and Naga Hills	900	63	2·7	14·5	...	...	...	...	...	59	83	15·4	·24	48	356	509	2·8	14	...
	Guzerat Party	1,696	134	2·7	11·9	...	...	...	...	...	99	245	6·4	·17	116	569	908	0·2	10	8
	Kattywar Party	1,350	59	2·04	6·1	...	...	...	...	...	46	94	13·6	·9	101	371	603	1·1	121	...
		4,489	298	2·7	8·0	...	...	...	...	...	237	494	...	...	298	1,447	2,288	...	261	8
4 inches = 1 mile.	No. 1 Party, Gwalior and Central India	32	12	1·4	6·5	...	...	...	...	...	9	33	6·9	·106	3	14	29	0·26	2	...
	No. 8 Party, Mysore ...	43·7	26	0·31	0·22	...	...	...	...	...	23	37	10·4	·59	19	128	253	1·1	94	81
		75·7	38	0·44	0·64	...	...	...	...	...	31	70	...	...	22	142	282	...	96	81
6 inches = 1 mile.	No. 5 Party, Bhopal and Malwa	11	6	·23	...	...	...	...	...	...	4	14	20·5	·77	...	45	87	1·6	...	...
		11	6	·23	...	...	...	...	...	...	4	14	...	...	...	45	87	...	...	...
	Total ...	22,674	668	...	...	...	...	...	...	...	521	1,239	...	...	589	4,029	7,060	...	1,622	3,575

PARTIES, between 1*st October* 1878 *and* 30*th September* 1879.

Scale of Survey.	Topographical Survey.	Traverses.							Topography.			Names of districts, &c., through which the season's operations have been carried.	Area of triangulation in advance of topography.
		Number of stations at which the theodolite was set up.	Linear miles, simple traversing.	Linear miles—boundary survey.	Average angular error per station in seconds.	Average error per 1,000 links in links.	Number of village trijunctions fixed.	Number of plane-table points fixed.	First topography completed during the season, in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test line run.		
½ inch = 1 mile.	No. 7 Party, Rajputana	.....	.....	.....	...	...	...	...	5,424	2·4	.....	Bickaneer, Jodhpore, and Shaikhawati.	15,000
		.....	.....	.....	...	...	...	...	5,424	...	.....		15,000
1 inch = 1 mile.	No. 1 Party, Gwalior and Central India	.....	.....	.....	...	...	...	...	2,298·3	7·6	94·6	Oodeypore, Jodhpore, and Malani...	5,930
	No. 2 Party, Khandesh and Bombay Native States ...	.....	.....	.....	...	...	...	...	642·0	8·0	32·5	Chota Udepur, Mathwar, and Kathi	.....
	No. 5 Party, Bhopal and Malwa	.....	.....	.....	...	...	...	...	2,252·1	7·7	162·6	Gwalior, Indore, Jabua, Dhar, and Ratlam.	3,276
	No. 6 Party, Garo, Khasi, and Naga Hills	.....	.....	.....	...	...	...	...	218·0	2·5	.....	Khasi and Jaintia Hills, Sylhet, &c.	.....
	No. 8 Party, Mysore ...	.....	.....	.....	...	...	...	...	3,367·4	7·6	194·6	Bangalore, Kolar, Chiteldroog, and Tumkur.	18,998
		.....	.....	.....	...	...	...	...	8,777·8	...	484·3		28,204
2 inches = 1 mile.	No. 2 Party, Khandesh and Bombay Native States	1,433	613	.....	4·1	0·05	495	...	892·7	30·2	227·9	Khandesh	2,144
	No. 6 Party, Garo, Khasi, and Naga Hills	.....	357	109·0	...	...	...	...	82·0	...	.....	Sylhet	900
	Guzerat Party	4,201	729·6	408·6	14·0	1·7	...	Not given.	1,220·0	19·4	622·6	Parouty, Kapadwanj, Mahi Kanta, and Rewa Kanta.	2,827
	Kattywar Party	1,257	420·8	42·9	17·4	1·5	...	...	1,835·2	12·9	423·0	Junagarh, Nawanagar, Porebander, and Baroda.	1,350
		6,890	2,120·4	558·5	...	...	495	...	4,029·9	...	1,273·5		7,221
4 inches = 1 mile.	No. 1 Party, Gwalior and Central India	34	.....	24·5	1·0	1·4	...	...	32·3	33·8	14·5	Pachpadra Salt Pits (Jodhpore) ...	.....
	No. 8 Party, Mysore ...	.....	.....	34·9	...	...	...	...	36·3	53·6	.....	Nundydroog and Devaraydurga State Forests.	.....
	Guzerat Party	.....	.....	.....	...	...	...	...	149·2	55·9	8·0	Dang Forests (Khandesh)	324
		34	.....	59·4	...	...	...	...	217·8	...	22·5		324
6 inches = 1 mile.	No. 5 Party, Bhopal and Malwa	.....	.....	.....	...	...	...	...	7·55	55·9	.....	Dewas city (Dewas)	.....
	Ditto ditto ...	.....	.....	6·01	9·0	6·5	...	35	Not surveyed in detail			Sirdarpore Cantonment (Gwalior)...	.....
		.....	.....	6·01	...	...	...	35	7·55	...	.....		.....
12 inches = 1 mile.	No. 1 Party, Gwalior and Central India	.....	.....	.....	...	...	...	...	10·78	...	.....	Oodeypore city (Oodeypore) ...	.....
	No. 5 Party, Bhopal and Malwa	.....	.....	.....	...	...	...	...	15·34	...	.....	Indore city (Indore)	.....
		.....	.....	.....	...	...	...	...	26·12	...	.....		.....
	Total ...	6,924	2,120·4	623·9	...	...	495	35	13,483·2	...	1,780·3		50,749

Summary of the results of the work of the Parties of the REVENUE BRANCH, between 1st October 1878 and 30th September 1879.

Scale of Survey.	Designation of Survey Party.	Where employed. Province.	Where employed. District.	Number of villages.	Area completed. In detail.	Area completed. In triangulation and traversing.	Check survey.	Total cost.	Average rates per square mile.	Remarks.	Explanatory references.
					TOPOGRAPHICAL AND MOUZAWAR SURVEYS.						
					Sqr. miles.	Sqr. miles.	Linear miles.	Rs. A. P.	Rs. A. P.		
2 inches = 1 mile	3rd Rev. Party ...	North-Western Provinces	Saharanpur	.....	1,067	.....	432	48,377 2 9	31 3 8	Topographical.	
	Ditto ...	Ditto ...	Muzaffarnagar	.....	482	1,250					
	10th ditto ...	Bombay	Ahmednagar	.....	2,215	1,400	268	49,011 6 7	22 2 0	Ditto.	
	Ditto ...	Ditto	Poona								
	11th ditto ...	Ditto	Sholapur	.....	1,402	2,388	216	32,116 6 0	22 14 6	Ditto.	
	Ditto ...	Ditto	Satara								
			Total of 2-inch Survey ...	.....	5,166	5,038	916	1,29,504 15 4	25 1 1		
4 inches = 1 mile	1st Rev. Party ...	Punjab	Dera Ismail Khan	24	469	.....	138	68,010 9 11	33 10 5	Mouzawar.	(a)—Includes 177 square miles of overlap survey on districts of Ferozepore, Montgomery, and the States of Bahawalpur, Bikaneer, and Patiala.
	Ditto ...	Ditto	Bannu	50	1,346	.....					
	Ditto ...	Ditto	Rawalpindi	80	206	451	.....				
	2nd ditto ...	Ditto	Sirsa	340	1,573(a)	.....	261	57,878 3 0	36 12 9	Ditto.	(b)—An assumed estimate of Rs. 55 per square mile has been adopted for the 4-inch survey.
	Ditto ...	Ditto	Jhelum	.....	.....	455	.....				
	3rd ditto ...	Ditto	Umballa	.....	87	.....	.....	4,785 0 0	(b)	Villages adjoining Jumna river.	(c)—Includes Rs. 2,683 recovered from Irrigation Department towards extra cost of 4-inch survey.
	Ditto ...	North-Western Provinces	Saharanpur	.....	22	.....	.....	1,210 0 0	(b)	Patri forest.	
	4th ditto ...	Ditto ...	Budaun	.....	.....	.....	.....	20,729 4 1	.....	Mapping only.	
	5th ditto ...	Ditto ...	Banda	64	148	.....	35	8,140 0 0	(b)	Native States and reserved forests.	(d)—The cost of the large scale survey is included in the total cost given above.
	7th ditto ...	Bengal	Pooree	.....	52	.....	.....	2,860 0 0	(b)	Overlap survey.	
	9th ditto ...	Ditto	Cuttack	.....	13	.....	.....	660 0 0	(b)	Block connecting survey operations.	
	11th ditto ...	Bombay	Sholapur	.....	576	.....	.....	15,870 8 8(c)	.....	For Irrigation Department.	
			Total of 4-inch Survey ...	.....	4,491	906	434	1,80,143 9 8	35 0 5		
6 inches = 1 mile	3rd Rev. Party ...	North-Western Provinces	Saharanpur	.....	13·2	.....	.....	(d)	.....	City and Civil station of Saharanpur.	
16 inches = 1 mile	1st ditto ...	Punjab	Shahpur	.....	1·6	.....	.....		.....	Sakesar Sanatarium.	
80 inches = 1 mile	10th ditto ...	Bombay	Ahmednagar	.....	0·6	.....	.....		.....	City of Sangamner.	
	11th ditto ...	Ditto	Satara	.....	2·3	.....	.....		.....	City of Satara.	
			Total of City Surveys ...	.....	17·7	.....	.....	.....	.....		
			Total of Topographical, &c., Surveys	.....	9,674·7	5,944	1,350	3,09,648 9 0	.....		

Summary of the results of the work of the Parties of the REVENUE BRANCH, between 1st October 1878 and 30th September 1879—continued.

Scale of survey.	Designation of Survey Party.	Where employed. Province.	District.	Number of villages.	Area completed. In detail.	In preparatory traversing.	Check survey.	Total cost.	Average rates per acre.	No. of fields.	Average size of fields.	Remarks.	Explanatory references.
					CADASTRAL SURVEYS.								
					Acres.	Square miles.	Linear miles.	Rs. A. P.	Rs. A. P.		Acre.		
16 inches = 1 mile.	4th Rev. Party ..	N.-W. Provinces.	Moradabad ..	....	.....	.. ...	.....	10,403 13 4	.....	.....	.....	Mapping only.	
	Ditto	Ditto ..	Ghazipur ...	197	78,458	358	267	48,489 4 5	0 9 11 (*e*)	145,293	0·54	.....	(*e*) This is the first season in a new district; the rate is consequently high.
	5th ditto ...	Ditto ..	Banda ...	226 (*f*)	325,233 (*f*)	.. ..	860	1,00,088 12 8	0 4 11	188,841	1·29 (*g*)	.....	(*f*) Excludes 163 villages, area = 61,233 acres of revision survey in parkana Chibbu, district Banda.
	Ditto	Ditto ...	Mirzapur ...	...	.. ...	101	... .		.....	.....	.....		
	Ditto	Ditto ...	Muttra and Banda	.....	.....	.....	.....	3,659 0 0	.....	.....	.....	Preparation of lithographic traces.	(*g*) The average size of fields is exclusive of hill tracts.
	6th ditto	Ditto .	Jaunpur	873	258,505	285	1,408	95,132 0 10	0 5 11	754,738	0·34		
	Barkagarh Party ...	Bengal	Lohardugga ...	35	22,640	41 (*h*)	13	14,647 4 5	0 10 4	32,600	0·69	Barkagarh, Salem, and Patia estates.	(*h*) This area was surveyed in boundary for Civil Department.
	8th Rev. Party ..	Assam	Cachar	28	25,106	91	50	45,615 4 5	(*j*)	24,065	1·04		
	British Burma Rev. Party	British Burmah ...	Hanthawaddy ...	22	19,844	184	.. ...	52,799 10 10		22,224	0·74 (*i*)	.....	(*i*) Size of fields is exclusive of forest tracts.
			Total of 16-inch scale	1,331	729,786	1,060	2,538	3,70,835 2 11	0 6 0	1,167,761	0·62		(*j*) The rates for Cachar and Hanthawaddy districts would, if recorded, be misleading, this being the first season of operations of new Parties in new districts.
32 inches = 1 mile.	7th Rev. Party ...	Bengal	Pooree	402	151,992	177	716	1,05,128 3 6	0 11 1	552,275	0·27	Khorda estate.	
	9th ditto ...	Ditto	Cuttack	798	189,386	.....	716	96,311 14 11	0 8 2	1,174,747	0·16	Irrigation tracts.	
			Total of 32-inch scale	1,200	341,378	177	1,432	2,01,440 2 5	0 9 5	1,727,022	0·20		
					Square miles.								
			Total of Cadastral Surveys	2,671	1,673·7	1,237	3,970	5,72,275 5 4	.....	2,894,783	.....		
			Total area surveyed of all scales ...	.....	11,348	7,181	5,330	8,81,923 14 4	.....	.....	.....		

Summary of the results of the work of the Parties of the ***REVENUE BRANCH,*** *between 1st October* 1878 *and 30th September* 1879—concluded.

ABSTRACT ACCORDING TO JURISDICTIONS.

Number of Parties.	PROVINCE.	Scale of survey.	Area surveyed in square miles.	Cost, inclusive of contingent expenses.	Average rates per square mile.	EXPLANATORY REFERENCES.
				Rs. A. P.	Rs. A. P.	
4	North-Western Provinces...	2′ = 1 mile ...	1,549	47,662 2 6	30 12 4	(*k*)—Includes city surveys.
		4″ = 1 ,, ...	183 (*k*)	30,794 4 1 (*l*)	.....	(*l*)—Includes cost of Budaun mapping.
2	Punjab	16″ = 1 ,, ...	1,035	2,67,772 15 3	235 7 6 (*m*)	(*m*)—The rate is exclusive of the cost of Moradabad mapping, and of Banda and Muttra lithographic traces.
		4″ = 1 ,, ...	3,683 (*k*)	1,30,673 12 11	35 7 8	
3	Bengal	2″ = 1 ,, ...	64	3,520 0 0	(*b*)	(*n*)—Includes cost of 41 square miles of village boundary survey. Rate enhanced owing to very scattered nature of survey operations.
		16″ = 1 ,, ...	35	14,647 4 5 (*n*)	417 7 9 (*n*)	
		32″ = 1 ,, ...	533	2,01,440 2 5	377 15 0	
1	Assam	16″ = 1 ,, ...	39	45,615 4 5	(*j*)	
2	Bombay	2″ = 1 ,, ...	3,020 (*k*)	96,998 5 3 (*c*)	23 1 10	
		4″ = 1 ,, ...	576			
1	British Burma	16″ = 1 ,, ...	31	52,799 10 10	(*j*)	
		Total ...	11,348	8,81,923 14 4		

DISTRICTS COMPLETED SINCE LAST REPORT.

DISTRICTS.	Scale.	SURVEY. When commenced.	SURVEY. When finished.	BY WHOM SURVEYED.	Area in square miles.	Cost, inclusive of contingent expenses.	Final rates per square mile.	EXPLANATORY REFERENCES.
						Rs.	Rs. A. P.	
Bannu (Punjab)	4′ = 1 mile ...	1874-75	1878-79	Colonel H. C. Johnstone, C.B., and Captain H. Lees.-Smith.	4,075	1,74,817	42 14 4	(*o*)—Includes 175 square miles of river and overlap.
Sirsa (,,)	4″ = 1 ,, ...	1876-77	1878-79	Captain E. H. Steel and Lieut.-Colonel D. Macdonald.	3,004	1,19,576	39 12 11	(*p*)—An additional expenditure on mapping necessitated a change in the rates from those previously given in 1876-77 and 1877-78.
Budaun (North-Western Provinces) ...	4 = 1 ,, ...	1875-76	1877-78	Major William Barron	2,162(*o*)	1,31,783(*p*)	60 10 9	
Moradabad (including pargana Kashipur, district Tarai). ...	16″ = 1 ,, ...	1871-72	1876-77	Majors A. D. Vanrenen and William Barron.	2,492	4,95,174(*p*)	198 11 3	

DEPUTY SURVEYOR-GENERAL'S OFFICE;
Calcutta, 1st January 1880.

F. CODDINGTON, *Major,*
Deputy Superintendent at Head-Quarters.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report, dated September 1879, *of* LIEUT.-COL. B. R. BRANFILL, *Deputy Superintendent, 2nd grade, in charge of the Madras Party, season* 1878-79.

ON the cessation of the autumnal rains of Madras, this party left Bangalore the first week in November, assembled in camp at Vellore on the 8th, and marched, as soon as carriage could be obtained, southwards through the country remaining to be triangulated (North and South Arcot) to the locality where the work of the previous season had terminated, the 'tween-water, or *doáb*, of the Vellár and South Pennár rivers, visiting *en route* the old survey stations.

I divided the party and distributed the work as follows:—Mr. Belcham to the approximate series on the left or west flank in communication with Mr. Potter, who was to do the same on the east or right flank, whilst Mr. Bryson proceeded with all despatch to complete the scaffolds and platforms at the stations selected in advance during the previous season, and to carry on the building of the stations and clearing the rays now selected and commenced by the others. I myself supervised and assisted to carry on the approximate series until it was well out of the difficult ground south of the Pennár and in sight of the first hills met with, after which I proceeded to take up the final observations. At the outset of the season I had the misfortune to lose a valuable horse, and was detained for a week, until I could procure another.

During the previous season (1877-78) the series had been brought up from the south through Tanjore as far as the Coleroon (Kolladam) river, and the stations of one figure in advance, a heptagon, had been selected (and their masonry pillars built), spanning the scrub-covered uplands of the *doáb*, or 'tween-water, between the Kolladam and Vellár river valleys.

To cross the Vellár valley I designed a quadrilateral, which Messrs. Belcham and Potter found little difficulty in carrying out. With reference to the ground in advance, between the Vellár and South Pennár, 20 miles or more in length meridionally—consisting of the Cuddalore (Gúdalúr) laterite (red gravel) uplands, a slightly undulating plateau of sloping flats covered for the most part with low bush—this proved a very difficult piece of country to get over, as such formation must be, unless its ridges happen to be suited for the requisite triangulation, which is unlikely to occur, and was very far from being the case in this instance, especially so as the river valleys to the south and north demanded extra long rays to cross them; whilst this intervening ground was cramped and narrow, demanding uncommonly small triangles. It occupied us until the end of December to find out and decide on the best, or rather the least bad, plan for carrying the series over it; and even then it was necessary to combine together a small and irregular pentagon on the upland wavy plateau, with two-thirds of a large and irregular hexagon, spanning the Pennár valley, into one compound figure of very unsymmetrical proportions. I accepted this arrangement with reluctance, and not until I had satisfied myself by personal examination that it was the best the country admitted under the circumstances.

North of the South Pennár we were able to make use of the isolated rocky hillocks or mounts, the first natural elevations we had met with since quitting the Great Arc series in latitude 9° five years ago (1874-75), by which the approximate series became comparatively easy, and my continued presence no longer necessary.

I commenced the final observations on the 27th December at Kulattúr Trs. S., and continued the work at the stations as noted below without interruption, except from occasional bouts of rainy weather, until the 29th of March, when, having overtaken the approximate series, I closed the work, having fixed 17 new principal stations forming 24 triangles, composing one heptagon, two quadrilaterals, and a large compound figure, covering 1,121 square miles, and advancing the series 77 miles northwards along the meridian, rather more than half way to its completion (at Madras); comprising also two sets of circumpolar star observations for azimuth, which I took at the beginning and towards the end of the season's work, besides a fair proportion (40) of well-marked secondary points.

	Station.	Date of visit.	Remarks.
Heptagon ...	Kulattúr ...	Trs. S. 27th December	West flank.
	Kachiperumál ...	„ 31st „	Ditto.
	Nayinipiriyán ...	„ 4th January (azimuth)	Ditto.
	Tirupanandal ...	.....	.....
	Salpai ...	„ 13th „	Centre.
	Kuchur ...	„ 20th „	East flank.
Quadrilateral ...	Podaiyúr ...	„ 24th „	Ditto.
	Aiyampet ...	„ 28th „	West flank.
Compound figure ...	Kanádakandán ...	„ 3rd February	Ditto.
	Séppalanattam ...	„ 7th „	East flank.
	Vallam ...	„ 12th „	Ditto.
	Kovilánkuppam ...	„ 15th „	Centre.
	Ulumdúrpet ...	P. S. 19th „	West flank.
	Chéndamangalam ...	Trs. S. 23rd „	Centre.
Quadrilateral ...	Kiliyúr ...	Rock S. 1st March	West flank.
	Mallipat ...	„ 5th „	Ditto.
	Kallapat ...	Trs. S. 10th „ (azimuth)	East flank.
	Perumukkal ...	H. T. S. 19th „	Ditto.
	Chenji ...	Rock S. 26th to 29th „	West flank.

Of the approximate series in advance, one complete figure is ready and another selected; and I have little doubt but that the remaining portion required to bring the work up to the Madras observatory will be done in good time during the ensuing season. I regret that owing to the illness of one of my assistants I was unable to detach a party for the connection and determination of the principal light-houses and landmarks on the coast, but hope to have this done next season. This, however, is not of such paramount importance as it otherwise would be, as Colonel Lambton's first great meridional triangulation extended from Madras to the south, adhering closely to the coast line all the way as far as Negapatam (Nágapaṭṭanam), and fixed the principal landmarks.

During the previous recess the 24-inch theodolite in use with this party (No. 1, by Troughton and Simms, altered) had been sent to the Government Mathematical Instrument Department, Calcutta, for the adjustment of the horizontal limbs, and only returned just as the party was about to take the field. I am glad to report that it is much improved, and pleasanter to use than I have ever known it before during the last 15 years. It had been so bad last year that I hesitated to observe an azimuth with it. The improvement is shown by the tabular abstract of tests of the triangulation attached, which proves that in every particular the results are better this season than last (when they were worst of all), and better than the mean of the previous four seasons; and that in the e^2, *relative weight*, *probable error*, *central*, *side*, and *cumulative errors*, the results of the observations are better this season than in any previous season since quitting the Great Arc and entering the plains. Notwithstanding the improvement in *relative weight* and *probable error*, I am sorry to notice that the triangular error is still very large (0·73″). The mean of the 64 angular corrections computed is 0·31″, with a mean probable error of 0·15″. There is every prospect of completing the series during the ensuing season, when I am apprehensive that a large closing error will become manifest, generated no doubt in the very unfavourable ground for triangulation which we have had to contend with during the past five years. The closing errors of the various series completed with this instrument, and observed principally by myself, have been very small indeed, namely, on the base lines at Bangalore and Cape Comorin, and on the Chandraguṭi-Halebail, near Kárwár, south of Goa, on the Mangalore meridional series, in neither of which cases did the closing error exceed (0·1″) one-tenth of an inch per mile. But those series had all been carried through comparatively very favourable country, in which the stations were nearly all well elevated above the general level of the country, and the signals therefore (comparatively) very good; whereas during the last five seasons, since leaving the Great Arc series in latitude 9° in 1874-75, this series has lain entirely in low, flat ground, devoid of hills, necessitating short sides and many stations, combined with bad signals and abnormally low and irregular refraction. For the sake of economy, both signal and instrument have been raised as high as practicable by means of wooden platforms and scaffolds, and so far this seems to have been attended with much success; but although I have been most careful to secure accurate plumbing of the signals, I cannot but fear that some of the large triangular errors noticed, and the closing error anticipated, may be due to erroneous plumbing of the signals at the stations forming the small triangles, as well as to the grazing rays. At present I can only hope that such errors may have cancelled one another.

The introduction of kerosine oil-burners for the signal lamps this season has no doubt been an improvement, but principally so perhaps from an economical point of view, my new signal apparatus being only about half the weight of the old, and the oil burnt much cheaper.

It was designed that this series should approximate to the coast line, but it was found that by adhering close to the coast (as Colonel Lambton did) the series would be much cramped and greatly retarded by the low-lying swampy flats and the groves of palms that fringe the sea-board. I have therefore obtained your permission to keep the line of the series a little further inland, by which we have avoided those sources of delay, and have fallen in with the outlying hills and rocks so much the sooner. Moreover, a tract of country has been covered with survey stations or fixed points which was previously devoid of any, lying as it does between the old Madras coast triangulation, executed by Colonel Lambton, 1802-1803, and the more general network of minor triangulation to the westward (shewn on Colonel Lambton's chart), which apparently only extends as far east as convenient hills were found, leaving a great gap which this season's work has happily filled up. I have been able to connect my work with several points of this old triangulation on either side, which may now therefore be checked and utilized for geodetic purposes.

Extract from the Narrative Report, dated 16th July 1879, *of* Captain J. Hill, R.E., *Assistant Superintendent, 1st grade, in charge of the Eastern Frontier Series, season* 1878-79.

In order to execute the Bangkok triangulation as quickly as possible, it was decided to employ the whole strength of the party on that work, and allow the principal triangulation to remain in abeyance until the following season. It was my original intention that Mr. Beverley should extend the Bangkok triangulation due east, from a base formed by a side of one of the principal triangles of the Eastern Frontier Series, situated in the same latitude as that of the city of Bangkok, and that I should go direct to Bangkok and triangulate due west from that city until a junction should be made between our triangulations, when the work would be complete. The whole length of this series, which is the shortest possible between Bangkok and the Eastern Frontier Series, is 130 miles. This plan aimed at finishing

off the work in one season; but having now experience both of the very difficult mountainous country lying between the base of the triangulation and the Siamese frontier, and of the flat tracts surrounding the city of Bangkok, I believe I was mistaken in thinking that the work could have been finished in one season, even if the rains had ceased early and so allowed us to take the field sooner than we did.

The field season, 1878-79.

4. As things turned out, the rainy season continued to an unusually late date, and I was unable to assemble the party at Tavoy, preliminary to commencing operations, until the 16th November. The Bangkok triangulation, in order to reach the Siamese frontier in the neighbourhood of the Amya Pass, which I had chosen as the most suitable point for crossing the frontier, had to be extended through the hill jungles to the south and south-east of Tavoy across the Bean and Tenasserim valleys. This part of the country is considered especially malarious at two seasons of the year, namely, immediately after the termination of the rainy season, and again at the end of the dry season, when the showers which precede the south-west monsoon have been falling. I was obliged to modify my original plan of operations to suit the lateness of the season as follows: I decided to proceed in the first instance to the neighbourhood of the Amya Pass, and there, in conjunction with Mr. Beverley, choose two stations on the frontier range of mountains which would serve me as a base of extension to Bangkok, and which it would be Mr. Beverley's duty to connect with the original base in the Eastern Frontier Series. Thus Mr. Beverley would not have to work in Siam, but would be responsible for the triangulation (about 40 miles in length) on the British side, while I, assisted by Mr. McCarthy, would extend the triangulation on the Siamese side from the frontier as far in the Bangkok direction as the time available would permit.

5. From Tavoy there are two routes to the Amya Pass,—one by road for two days in a north-easterly direction as far as Myitta, a village situated on the Tenasserim river, and thence for three days in a south-easterly direction by water, down stream to the village of Amya, which is situated on the Tenasserim river about 11 miles below the Amya Pass. This is the usual route, but it is not practicable for elephants. The other route follows a good road southwards as far as the village of Toumbyouk, which lies between the two stations (Nwatabo H.S. and Natyadoung H.S.), forming the extremities of the base from which the Bangkok triangulation emanates. It then turns eastwards and follows the line of the Bangkok triangulation all the way to the Amya Pass by a track over the mountains and across the Bean and Tenasserim valleys, which, when sufficiently cleared, is practicable, though very difficult, for laden elephants. Being provided with elephant transport, which is the only kind of carriage suitable for getting about in the almost uninhabited jungles of this part of the interior, I adopted the latter route; and as it traverses the tract of country over which it was arranged Mr. Beverley should triangulate, and as I wished to make myself acquainted with the whole line of country over which the series would pass, I decided that both he and I should go through it. I therefore despatched a party of men to clear the track in advance, and Mr. Beverley's camp followed them on the 26th November.

6. Mr. Knox had arranged with the Siamese Government that there should be attached to my party, while in Siam, responsible officials, through whose agency we should obtain all our supplies and assistance of every kind. Siamese interpreters and guards were also detailed to accompany the survey camps. Mr. Knox also suggested and obtained permission that I should be allowed to retain my own armed police guard with my head-quarters during my stay in Siam, an arrangement which proved very advantageous. I had requested that the Siamese officials should if possible be sent to meet me at the village of Myitta, which I have already explained is two days' march from Tavoy. On the 21st November I received notice of the arrival there of two officials, Looung Kryna Ry and Looung Na Ra,* accompanied by two police-officers and an interpreter, and the same day I wrote to them requesting them to come in to Tavoy and consult with me there as to our future movements. They arrived on the 25th, explained their instructions, and agreed to all the arrangements I proposed to them. They had left their baggage and escort at Amya, and had travelled lightly by boat up the Tenasserim river to Myitta; so I requested them, after they had had sufficient rest at Tavoy, to return by the same route to Amya, and I deputed Mr. McCarthy to accompany them and have everything ready at Amya in anticipation of my arrival there by the elephant route. I also directed Mr. McCarthy to inspect the ground about the Amya Pass if possible, and endeavour to select a point suitable for one of the stations of the frontier base of extension. On the 29th November I moved my head-quarters camp out of Tavoy, and commenced my march towards the Amya Pass.

7. Showers of rain still continued to fall occasionally in the Tavoy district, although they had ceased in the northern parts of Tenasserim. The village of Toumbyouk was reached without trouble, but the four days' journey from it to the next village (Khyouk Hton), across a steep mountain range, in climbing which the elephants frequently slipped and tumbled and dropped their loads, was difficult and trying. Khyouk Hton village is situated on the Bean river, one of the head-waters of the Tenasserim river, and consists of a few huts inhabited by Karens. On arriving there we were caught in the rain, which had recommenced heavily, and were obliged to halt for one day. Between Khyouk Hton and Amya there are no intermediate villages. This part of the journey, in which we had to cross the high mountain range which separates the Bean and Tenasserim valleys, occupied us a week, the marching being made exceptionally difficult by the state of the weather. It rained every

* The Siamese title of Looung is conferred by the King, but does not seem to give any very definite rank.

day, and we had to struggle through swamps and dripping jungle, the elephants sometimes up to their bellies in thick mud, and sliding and dropping their loads on the slippery ascents and descents. The wet tents had to be pitched on still wetter ground; and although every precaution was taken to keep the men in good health, it is not to be wondered at that they did not escape the usual consequences of such exposure. We reached the village of Amya on the 18th December, and the rains ceased the same day.

8. Mr. Beverley, who had been marching three days' journey in advance of me through the same almost uninhabited wilderness, and who had also found the march most trying, was at Amya when I arrived there. Mr. McCarthy had also arrived with the Siamese officials by the Myitta route several days before me; but the unhealthiness of Amya had alarmed the Siamese, and before my arrival most of them had crossed over into Siam, ill with fever. Three of their number died at Amya, and a fourth died on crossing the Pass. There remained, however, with Mr. McCarthy the Senior Siamese official (Looung Kryna Ry), the police-officer attached to him, and an interpreter. I believe that the sufferings of the Siamese at Amya were in a great measure due to their neglect of the most elementary sanitary precautions while they were encamped in one confined spot, but they did not suffer in a similar way in their own country; and there can be no doubt that the Tenasserim Valley and the adjacent parts of the Tavoy district are malarious, while the part of Siam to the east of the Amya Pass, of which I have experience, appears to be healthy. The village of Amya was formerly inhabited by Karens. At present the villagers are chiefly people of Siamese race, and the Karens have removed to other places in the neighbourhood.

9. After a day's halt to dry the tents and baggage, I proceeded, accompanied by Messrs. Beverley and McCarthy and the abovementioned Siamese officials, to the Amya Pass. The Pass is about 2,300 feet above sea-level and 2,000 feet above the village of Amya. The path to it is up a stony ravine, and is about eleven miles in length. It is passable, but not easy, for laden elephants; but with a little trouble it could be much improved. On arriving at the water-parting the marks cut upon the trees by Lieutenant Bagge, R.E., indicating the boundary beween British and Siamese territory, were found in good order and plainly visible. We encamped at the Pass on the evening of the 20th December, and the next morning we visited a peak close to the Pass, to the south-east, which Mr. McCarthy had selected and nearly finished clearing before my arrival at Amya. The peak, called by the Karens on the British side Nekia Toung, and well known to the Siamese as Kow Den, or Boundary Hill, was a very good selection, suitable both for the forward work in Siam and for Mr. Beverley's triangulation: I therefore accepted it. A second mountain summit, also on the frontier, was visible about 15 miles to the south, and was evidently suitable for the same purposes.

10. The country through which Mr. Beverley had to triangulate is bounded on the east by the frontier range which separates British from Siamese territory; on the west by the Nwatabo range, which overlooks the Tavoy river and the sea-coast, and midway between these exterior ranges it is bisected by a short, but high, range which joins the Nwatabo range of mountains a few miles south of Mr. Beverley's line of triangulation, at a point where they culminate in a peak called Myeng-mo-let-khat, which rises to a height of 6,860 feet above the sea. The Nwatabo and middle range form the water-basin of the Bean river, which rises among the ravines of Myeng-mo-let-khat and flows northwards as far as Myitta. The river, which from that point is known as the Tenasserim river, then turns east and, rounding the northern extremity of the middle range, flows in a southerly direction to Amya, and thence eventually to Tenasserim and Mergui. Mr. Beverley's triangulation has its eastern extremity on the frontier range near Amya, its western extremity on the Nwatabo range, while between these limits it stretches across the Bean and Tenasserim rivers and the middle range which separates them. This part of the interior, as already mentioned, is almost uninhabited. The one path which traverses it has been already described in section 7. Both mountains and valleys are alike covered with dense forest and undergrowth, through which a surveyor is obliged to cut his way in order to reach his points. The greater part of it is unexplored, and very little is known of it even by the few Karens who are occasionally met with in the neighbourhood of the rivers. The difficulty and inconvenience of keeping up communications across the Siamese frontier with a surveyor working about in unknown directions in such a tract of country are obvious. I therefore arranged that Mr. Beverley should be entirely independent of me during the field season, and I hoped I should not have to think of his work until it came before me in the recess for calculation. But unforeseen circumstances, beyond Mr. Beverley's or my control, combined to disappoint my expectations.

11. Four days after Mr. Beverley left me to carry on his independent work, he wrote to me stating that the villagers on whom he had relied for assistance in clearing two stations on the central range separating the Tenasserim and Bean valleys, and others who had agreed to clear a way to the southern station on the frontier, were deserting and refusing to work; both he and a large proportion of his establishment were ill with fever; the best of the three elephants with which he was provided had fallen sick with some internal complaint, which incapacitated it from carrying its load, and he was obliged to send it to me to be cured. Under these circumstances he asked to be relieved from the duty of clearing the southern station on the frontier, and suggested that it should be assigned to Mr. McCarthy to visit from the Siamese side, it being understood that if one particular angle (namely that between the two stations above mentioned on the central range) was not ready for Mr. McCarthy, it would be observed later on in the season by Mr. Beverley himself. I agreed to this arrangement, and

Mr. McCarthy duly visited, cleared, and observed at the southern frontier station; but the doubtful angle was not ready for him, and he therefore, in pursuance of his instructions, left it unobserved and returned to his own immediate work. In the meantime Mr. Beverley had been proceeding with the selection and clearing of his stations.

12. I am glad to say that all his stations have been well prepared, and there are practicable approaches to them all, except to the southern station on the frontier, which cannot at present be reached except from the Siamese side; the path to it from the British side still requiring about four miles more cutting. He completed his final observations at Nehkia Toung H. S.; and although his other stations must be re-visited, as all their angles have not as yet been observed, I think that, considering the great disadvantages under which he laboured, he has accomplished a considerable amount of useful work.

13. Before marching into Siam from the frontier station near the Amya Pass, which is known to the Siamese, as already mentioned, as Kow Den, or Boundary Hill, the country in advance was carefully scanned, observations taken to peaks, and their names, as given by the Siamese who accompanied us, recorded. From the commanding position we occupied, the whole expanse of hill country over which the triangulation would extend eastwards lay before us. Beyond the hills, alluvial plains were dimly seen, giving a horizon line beyond which lay hidden the city of Bangkok. Having completed the necessary preliminary work at Kow Den, I proceeded (accompanied and assisted by Mr. McCarthy) with the selection and preparation of the forward stations. On the 30th December, having then arrived at my first forward station in Siam, I received a letter from Mr. Beverley detailing the difficulties he had experienced in the neighbourhood of Amya, and asking to be relieved from the duty of selecting and preparing the southern station on the frontier. So I despatched Mr. McCarthy on the 31st December with my 12-inch theodolite to the southern frontier station (called by the Siamese Kow Woi Noi), and I continued the work of selecting and preparing the stations in advance. Owing to the sickness which attacked the Siamese at Amya (see section 8), only the Senior Siamese official was present to arrange for assistance and supplies. He had to remain with the head-quarters camp, and Mr. McCarthy proceeded to carry out his instructions, having only an interpreter, who had been hired at Amya, to assist him in his intercourse with the people. He was consequently much delayed and obstructed at first; but the second official (Looung Na Ra), who had been laid up with fever at the town of Kanbooree, fortunately recovered in time to follow quickly after him, and with his help Mr. McCarthy reached Kow Woi Noi on the afternoon of the 19th January. On his way to this hill he succeeded in clearing and building another station on the southern flank of the series. Mr. McCarthy's regular observations were thus delayed until very late in the season. He, however, worked with great energy, and I found it feasible to entrust all the observing with the 12-inch theodolite to him, while I laid out the series in advance, took some extra observations with a 7-inch theodolite to determine the position of the town of Kanbooree and some additional peaks, and conducted the negotiations with the officials of the country. During the short time available for observing, Mr. McCarthy visited and observed from six stations, three of which he himself cleared and prepared. He completed the observations of two quadrilaterals, and took forward observations also, besides observations to a large number of peaks. In addition to his work, the position of Kanbooree has been determined by a short branch triangulation consisting of one quadrilateral and one triangle, and forward stations have been selected, the most advanced of which is to be on the Great Phra Pa Tom Pagoda (the largest in Siam), which is situated in the Bangkok plains, about 25 miles west of the city.

17. A general idea of the country triangulated in British territory has been already given in section 10. It consists of parallel mountain ranges (composed chiefly of metamorphic rocks), the highest range being that on the west, overlooking the sea, and all the country being densely covered with thick forest and undergrowth. At the Amya Pass the face of the country suddenly changes. On leaving British territory, a few paces take one into a forest of totally different character. The trees are less thickly crowded together, the undergrowth disappears, and the country is altogether more open. Carts are in use to within a distance of about six miles of the Pass, and a road could easily be made which would admit of their being taken actually up to the Pass, if it were worth while to make one; but the difficulty of the country on the British side makes such a work unnecessary. The character of the hills on the Siamese side of the Amya Pass is diversified, ranges of mural limestone occurring among the older hills, and the general elevation decreasing to the east until only occasional peaks and hillocks rise from the plains; and where they cease, there comes a stretch of about 50 miles of dead level country, forming the western part of the Bangkok plains. This dead level country (as far east as Bangkok) is bounded on the west by the May Klawng river, on the east by the Menam Chowphya, the river on which Bangkok is built, and bisected by the Tacheen river, all three rivers flowing from north to south. In addition to these main waterways, the plains are intersected in all directions by numerous creeks, some of which extend from one main river to another. Throughout this part of the country boats are exclusively used for transit, and houses (many of them floating ones) line the sides only of the rivers and creeks.

Extract from the Narrative Report of MR. W. C. PRICE, *Surveyor, 4th grade, Officiating in charge of the Eastern Sind Series.*

THE portions of Beluchistan over which the series has been carried were minutely described by Captain Rogers, R.E., in his narrative report for season 1877-78. The addenda that I am now going to make are more especially regarding the plain or Katchi extending

from the late General Jacob's towers, on the British Indian boundary, to the majestic ranges of mountains bordering it on the north, east, and west. This country, within the parallels of $\frac{29^{\circ}\ 18'}{28^{\circ}\ 23'}$ latitude and $\frac{67^{\circ}\ 25'}{66^{\circ}\ 31'}$ longitude, termed "a dead level," is not what the words literally imply. It is an extensive open plain, running up north like the back of a camel; the centre portion, indicating the spinal bone, being the highest. The gradient is about one in 1,372; Jacobabad, at its southern extremity, and Mittri, at its northern, being respectively 183 and 400 feet.

When the waters of the Indus and the upper hill streams rise with the rains and the melting of the snow, the lower portion of the Katchi gets flooded. These inundations cause great inconvenience to travellers, who have to detour either eastwards or westwards, to the foot of the hills, to get across.

Streams rising in the mountains of Khelat and Afghanistan find their way to the low country, and meeting, on their course to the larger rivers of Sind, irrigate the eastern and western parts of the Katchi as they pass through. The waters of some of these streams, notably the Léhri, are absorbed into the ground near Manuti before reaching British soil. This strange phenomenon is witnessed all over Beluchistan amongst the hills: *e.g.* in the Duzan nala, a short distance to the right of the Bolan highway, the water mysteriously disappears below the surface, to the great annoyance and discomfort of travellers.

The Katchi, on the eastern and western sides, is not only fairly inhabited, but dilapidated large towns bear testimony to the once thriving state of the province. The indolence of the inhabitants and their dread of being plundered prevent the irrigated lands, which are amply cultivated, from becoming gardens of luxury. The great central river of the Katchi is the Nari, that rises in the hills of Afghanistan, north of Sibi, and flows by Mittri and Bhàg (Bàgh), two famous towns, now much deserted. The Naibs or Governors of the provinces will not allow water to be utilized by the inhabitants unless they pay for it, when the bunds or dams are opened and the whole country watered for cultivation. There are very few tanks or wells, as good water can be carried down to any village on account of the Katchi being a natural drain. Water is bunded up in the *nalas* (channels) for consumption and use when no longer required for the lands. This season it was taken down to near Mahomed Khan's dry well, in the centre of the waterless Katchi, by a surface channel from Barshori, the first village in Central Katchi that is met with after leaving Jacobabad. This parched land may be turned into an oasis if labour and skill were spent on it.

The enemies of the place are the Marris and Bughtis, those unscrupulous freebooters who are the chief dread of the place; next, the Brahoes, who come down from all their mountain fastnesses to luxuriate on the smiling and less cold plains of their native land, bringing with them their flocks and herds and families, to live on the produce of the more favoured country. They are a pastoral race, have no fixed abodes, live in *ghedans*—black felt or coarse blanket tents of primitive manufacture thrown over a wicker framework, and resemble in all known respects the lost tribes of Israel. But the aboriginals of the plain are the Jats, who are most like the Musselmans of Sind, of the Sunni faith, a mild, and unwarlike race, and the Beluchis. These, together with the Brahoes, are divided and subdivided into endless sects. They all intermarry; but the Beluchis, to preserve their distinctiveness, say they do not give their daughters to the other tribes.

The climate varies extremely, from the burning heat of summer, when neither man nor beast can stir out of their shelter during the day, to the painful cold of winter. These extremes tend to make the people indolent and very averse to innovations, however beneficial.

The soil of the whole territory is extremely fertile, being a stiff, rich clay; its produce is jowari, maize, wheat, barley, bajri, rice, rye, and dall of kinds. Cotton and indigo thrive very well, and in the hills fruits of kinds too well known to be described here, and even assafœtida, are indigenous. The lucern grass, which is sown once in three or four years, is the favourite food of horses.

Melons and vegetable marrows attain a perfection unrivalled in India; English and Indian vegetable of almost every kind can be grown. The scarcity of vegetation is not due to the soil of the country, but directly to the people who inhabit it.

The Bolan highway has also been described by Captain Rogers, and travellers have not been slow to narrate the peculiarities of that immense ravine, bounded by dangerous, high, and precipitous cliffs, composed chiefly of stones and loose, deep, heavy shingle, the beds of considerable streams. A few words, however, regarding it may not be amiss. From Dadar, by a long tortuous ravine, through which is a newly-cleared military road over shingles, frequently crossing the running stream, the first march is to Kundelan, about 12 miles; the second to Kirta, a small Beluch village, is 15 miles; the third, to new Bibi-nani, named after an old woman who resided in a cave near the old camping ground of this name, is 7 miles. This encampment is half way up the extensive Kirta plain, 4 miles south-east of Ab-i-gum, literally "water is lost," a well-known place in the Pass. The fourth, to Mach, is 15 miles, on a small plateau, round which the stream winds by the north, from where the Upper Bolan may be said to commence. Mach is the chief commissariat depôt in the Bolan, half way between Dadar and Quetta. A telegraph and post-office are located there. The fifth, to Darwaza, or "gate" of the Pass, *vid* Siri Bolan and the mouth of the Duzan nala, is 20 miles. Siri Bolan is 5 miles from Mach, and the Duzan nala, 6 miles further, branches off the road to the right or north side, and runs up between the Shug (Shok), Zain, and Jalabgundan hills. A path up this stream crosses a Pass near the Zain hills, and meets the Chankani road for pedestrians in the Kharghost plain, north-east of Dasht-i-be-daulath,

and, winding through the Murdar range of mountains, falls into the Quetta plain, 4 miles south-east of Quetta. This is the shortest cut from the Bolan to Quetta, but is not much used on account of its being rough, waterless, and dangerous. The sixth march, from Darwaza to Siriab, is 17 miles; and the seventh, to Quetta, is 7 miles. From Darwaza the road runs north-north-east through the northern portion of the Big Dasht; then almost due north through the Shal valley, between the lofty snowy-ranges of Chiltan and Murdar.

The hills on both sides of the Bolan Pass range from 3,000 to 11,000 feet above the sea, and from 2,500 to 7,000 feet above the valleys, and are bleak and barren, but during the hot season are covered, wherever there is any soil, with grass. Fruit-trees are scattered about in the ravines.

The Dumar Pathans are the chief residents of the hilly country north of the Pass. They are one of numerous warlike tribes, whose spirit is the same as before; but high pay and employment, with chances of *loot* and raids on other tribes, keep them under respect and allegiance to the Imperial power. The Bolan has alas! too frequently been the hot-bed of highway cruelties, rapine, and bloodshed; was used in the 18th century by the armies of Nadir Shah and Ahmed Shah, and in the 16th century by the great Emperor Babar. It has been the road used to invade and expel invasion, and is now the most important southern route from Afghanistan into India.

Notes by Mr. C. P. Torrens, *Assistant Surveyor, on portions of the Jesalmer and Khairpur States.*

The western extension of the Jesalmer series, on which I was engaged for the early part of the season this year, passes through what must once have been a populous and fertile country. It is crossed by two small rain streams, which rise in the hills to the south-east of Jesalmer city, and flow northwards, eventually falling into the old bed of the Hakra, which tradition coupled with unmistakeable landmarks show to have once flowed here. Along the banks of these streams, named Hakra, are a number of fields of good soil, irrigated by them and utilized by the inhabitants. Numerous other bits of ground now lying fallow could with a little judgment be irrigated and brought under cultivation. The waters carried into the bed of the Hakra by the two streams above named, together with the drainage of the surrounding country, form themselves into extensive marshes, called *runs* by the natives. The one near Harda, a deserted town, is the most extensive, being about 8 miles long by 2½ broad. Others, less extensive, exist near Kathori, Khaba, Mohonghur, &c. The waters in these *runs* are, with one exception (Kathori), fresh. After the rains are over, the water recedes slowly, and the inhabitants sow their crops on the reclaimed sands. These marshes can all be drained more or less by a little engineering skill, their waters utilized for irrigating other lands, and their beds sown. Thus a large amount of land could be brought under cultivation with but little expense and judgment. In many parts of the bed of the Hakra large *jods*, or preserves, are kept for the Rajah's stud. These were once fields, but are now covered with heavy babool jungle. The marsh near Kathori is one which produces salt. It is very extensive, and I should think capable of producing an inexhaustible supply. The Durbar at present has but a small fraction of the expanse for his work, probably not even a five-hundredth part of the whole, and yet, in spite of the very rude appliances for making the salt, produces 20,000 maunds annually for consumption in his territories. The old towns met with were Khaba, Harda, Kathori, Konod, Lonida, &c., the first-named of which could boast of streets paved with stone, and contained 12,000 houses built of hewn stone, many of which yet stand and testify to the wealth and taste of the former inhabitants by their size and magnificent carving. The other towns were also important when in the zenith of their greatness, and contained from six to ten thousand stone-built houses. Two or more temples in each, built of nicely-cut and ornamental stones, prove their flourishing state. The nature of the country changes completely 40 miles west of Jesalmer; and instead of the remains of large towns, frequent fields, and a hard and rocky soil, hamlets of two or three huts are now and then met with. Nothing green charms the eye; and sand, and nothing but sand, in low hills alone meets the eye in all directions. The inhabitants of these towns were for the most part Paliwal Brahmins, or Brahmins from Pali in Marwar. They appear to have been an industrious people from the numerous remains of tanks, dams, wells, &c.

The second portion of the season was spent on the Sehwan series. It commences in and passes through the southern parts of the country of His Highness Mir Alimurad of Khairpur. For the most part the series passes over the tracts of loose shifting sand known as "Draen" in the locality, and alluded to by Captain Rogers, R.E., in his report of 1876-77. The colour of the sand in these tracts is of a dark cream, the particles of an uniform size, and quite clean, not the least trace of clay being present even when subjected to a washing in water. Marching over them is very trying and not free from danger, as occasionally the eye having been quite dazzled and the mind absorbed by the grandness of the scene, the edge of a precipice is approached unconsciously. A step over is a certain burial below the falling sand, as the sides are quite perpendicular, the sand having been scooped out by the action of the wind. Numerous deaths were reported as having occurred from this cause, especially when there was a storm blowing. Throughout these wastes are little tracts of from 250 feet to half a mile in diameter where the subsoil is bare. Green grass and a few trees are to

be seen in each, and occasionally a small pond or two with ducks and an antelope to enliven the scene. When a pond is wanting, water, fresh, soft, and crystal, still exists, and can easily be obtained by digging but six inches. These oases, as they may be termed, seem to be under the protection of the genii of the desert; the surrounding sand, which rises in hillocks to the height of 40 to 60 feet, as I was told, never intruding, the same oases having existed since the memory of man. Proceeding west, the "Draens" disappear, and only the ordinary run of sand-hills remain. These, however, are lower than those in Jesalmer and Marwar. Here and there between the ranges marshes of water are met with, producing large quantities of natron, from which the Mir gets a good revenue. I was unable to ascertain the exact quantity produced, but have no doubt that under careful management a much larger quantity should be obtained. Some of these marshes are of immense depth. One in particular, called Purchand, locally considered to be the origin of Noah's flood, is said to be unfathomable. The accuracy of this statement I was unable to test, as there were no means at hand. As, however, the question of its depth is very widely believed, it would no doubt repay time and trouble to measure it when the country is re-visited for observation.

Extract from the Narrative Report of MAJOR T. T. CARTER, R.E., *in charge No.* 1 *Topographical Party, Gwalior and Central India Survey, season* 1878-79.

Remarks on the country triangulated.

THE triangulation of the past season was done for a special purpose, viz. to afford points for the survey of the Luni river. It extends from parallel of latitude 24° 35′ to 26° 0′; the stations lie pretty equally on both sides of the river, embracing a tract of country about 12 miles in breadth. The southern portion of the triangulation comprised the delta of the Luni. The ground is for the most part quite flat, the level of the Runn of Cutch being 44 feet above the sea. Here and there sand-hills or ridges crop up, at first commencing with an altitude of some 90 feet, but gradually getting higher, till they attain a height of 264 feet in latitude 25°. Up to this point the country is in the Jodhpore State proper, as distinguished from Malani, that portion of Jodhpore which comes under British jurisdiction, and through which the triangulation extended northwards. The country now becomes more undulating, the sand-hills more marked and rising to a height of over 500 feet at the northernmost point fixed. The whole of this tract of country being a wilderness of sand-hills, was some few years back a refuge field for freebooters, who, having committed depredations in the neighbouring states of Palanpur or in Jodhpore itself, fled thither for shelter and protection from the law. The revenue is collected by the Political Agent, who, after deducting the amount necessary for the payment of various expenses and the establishment required to keep the country in order, makes over the surplus to the Jodhpore Durbar. The country is easy to triangulate, but the observer is much inconvenienced by the strong winds and consequent accumulation of sand on the instrument. The names of the four branches of the delta of the Luni river are the Khari, Moti, Luni, and Kharvi rivers; of these the Khari yields an abundance of salt, the Kharvi the next greatest quantity, the Luni only in certain places, and the Moti least of all.

The land on the banks of the Luni, called the Nayar, is a hard, stiff soil, and is productive of large crops of wheat. This soil barely extends for a distance of more than a mile and a half on either bank of the river, when the Thall, high sandy ground or desert, commences.

Remarks on the country plane-tabled.

The country plane-tabled during the past season consists of portions of Oodeypore and Jodhpore. Of the former 335 square miles were surveyed, being 147·4 square miles of standard sheet No. 83, and 207 square miles of standard sheet No. 87. The work in sheet 83 was traversed by two parallel ranges of hills running north and south, the easternmost being a continuation of the range called the Ara, forming the eastern limit of the Aravalli mountains. The country to the east of this range is undulating and dotted with fairly large patches of cultivation, but to the west it is one mass of broken intricate ground, with no grass or jungle. The ground in sheet No. 87 consists of broken hills, very steep, and in some places almost inaccessible; further, it is covered for the most part with thick bamboo jungle, which added considerably to the difficulty in surveying it. The remaining portion of the country plane-tabled during the past season consists of standard sheet No. 93, through which runs the river Luni, traversing this sheet from east to west. The country is open, covered with sand-hills rising to a height of from 200 to 250 feet above the surrounding country. The north-north-east face of these hills is invariably abrupt, whilst the south-south-west face has a gentle slope. This is due to the prevailing winds, which blow from the south-south-west. The representation of these hills in the map has a very curious effect. The remaining country surveyed consists of the 1,123 square miles of the Luni river survey (this country has been described under the heading of "Remarks on Country Triangulated"), and 285 square miles of sheet No. 94, of a similar country to that in sheet No. 93, except where the Kundal range enters the sheet, when the hills become very steep, rising to a height of 1,800 feet above the sea, but quite bare. This portion of the work was done by Abdul Aziz.

Forts, towns, and cities.

The city of Oodeypore, the survey of which on the 12-inch scale was completed during the past field season, has already been described by Lieutenant Hobday in Appendix to General Report, Topographical Surveys of India, for season 1875-76. The other towns of any size met with in the season's work are Dilwara, in sheet 83, the residence of the Rao of Dilwara,

one of the 32 minor chiefs of Oodeypore; population 3,300. The palace is built on the left bank of a small stream, and comprises one of the sides of a small fort consisting of four walls some 20 feet high and 200 feet long, with circular towers at the corners. Nathdwara, in sheet No. 83, a walled town, famous as a place of pilgrimage; Jharol, in sheet No. 87, the residence of one of the 32 Raos of Oodeypore, and a tehsil; Tilwara, in Malani, in Jodhpore, in sheet No. 93, noted for a large cattle fair held each year about the middle of March. In the same sheet, Jasol, Balotra, and Pachpadra, the latter the head-quarters of a Kamasdar, the official designation of the chief officer of a district in Jodhpore. These places have a population of about 5,000 people, and are chiefly inhabited by Marwar Baniahs, who export salt from the neighbouring salt-pits. Nagar and Gura, famous for a breed of horses, and Boitra, a large village in the delta of the Luni, were the chief places met with in the Luni river survey.

Hills and Passes.

The northern extremity of the Ara range comes into sheet No. 83; it forms the eastern limit of the Aravalli hills. Part of the Marwar range, which commences a little south of Oodeypore, comes into sheet 87.

In sheets Nos. 93 and 94, and that portion of the country through which the Luni runs south of parallel 25° 45′, the country is covered with sand-hills; the tract of sandy country lying on the right bank of the Luni river is called the Thall.

In sheet No. 83 (Oodeypore), on the main road between Oodeypore and Nathdwara, at the village of Odar, distant about two and a half miles from Nathdwara, the road passes through a narrow gorge about two miles long till it reaches the banks of the Banas river. It is practicable for laden camels; an alternative road branching off from the same village may be taken to Nathdwara. Mr. Tate says that camels could be taken by this road, thus avoiding the defile and having to cross the Banas river. North of the town of Eklingji the road to Dilwara passes through a very narrow gorge for a distance of three miles; it is, however, practicable for laden camels.

In sheet No. 87 (Oodeypore) the road from Oodeypore to Jharol *vid* Alsigarh, from the village of Roha to within a mile of the village Gorakaha, the road passes along the Bakri nulla. It is barely practicable for laden camels, and is also a dangerous pass on account of thieves. At the village of Tindol the high road between Khairwara and Oodeypore crosses the Marwar range; it is a fair road, practicable for camels.

Principal roads.

Through sheet No. 87 the road from Oodeypore to Khairwara passes. It is metalled and bridged throughout. For the protection of travellers there are *chowkis* along the road about twelve miles apart, and guards are supplied on payment to the headmen of villages in their vicinity. These guards escort travellers from *chowki* to *chowki*. Without this precaution the road is not safe on account of thieves. The road to Gogunda *vid* Jharol to Madri passes through this sheet; it is unmetalled.

The principal roads in sheet No. 83 are Oodeypore to Nathdwara, Nathdwara to Gogunda, and Nathdwara to Sembal Ghat, leading to Erinpura. This latter road would be impracticable in the rains; these are all unmetalled. In Jodhpore, *i.e.* in sheets Nos. 93 and 94, and the country traversed by the Luni river, there are well-marked cart tracks between all the larger towns and villages, but no metalled roads.

Rivers.

The Banas in Oodeypore, about 180 yards wide; not navigable. The Luni, in Jodhpore, in breadth nearly as much as half a mile; it is the greater part of the year a dry sandy bed, with pools of water here and there.

Products, soil, and cultivation.

Mr. Claudius mentions that about six miles south-west of Boitra, and in "the Runn," there was a vein of salt from which large blocks were obtainable. It was not being worked, and the openings had been closed up. Wheat and bajra are the cereal products; the former is grown in the Nayar land, or an alluvial deposit, extending for a distance of one to one and a half miles on either side of the river, commencing at the village of Nagar and extending down to the Runn. The wheat grown in the Nayar is entirely unirrigated; it is of a very good quality, due to the richness of the soil. It is chiefly exported to Palanpur. Bajra is sown in abundance all over the country, and forms the staple food of the people. In years of scarcity the common people have recourse to the seed of a grass called "bhurat," which grows in great abundance on the Thall. They grind the seed into a flour, and either mix it with bajra flour or eat it alone. Even in years of plenty it is largely consumed, piles of it being seen collected in each homestead. In "the Runn" there is a seed called "kasar," which is eaten by the poorer classes; it is also the seed of a grass peculiar to that part.

Extract from CAPTAIN C. STRAHAN'S *Report on the Survey of the Luni River.*

Remarks on the country visited.

THE country near the Luni river was, except a small strip near the river, almost entirely desert. Pachpadra itself is a large village, the existence of which depends entirely on the salt works near it. The appearance of the place is most dreary, for there is scarcely any cultivation to be seen anywhere, and green trees are almost unknown. Fresh water is only to be had from shallow tanks filled during the rainy season, or, if these fail, from Balotra, about five

or six miles distant on the right bank of the Luni, whence it is brought in skins (*pakals*) on camels. Besides these two sources of fresh water, I believe most of the well-to-do inhabitants build tanks underground, into which they conduct rain water for their own private use. The

Pachpadra salt-pits.

salt-pits are between two or three miles to the west of the village, occupying a depression in the country some 40 or 50 feet below the general level. This low-lying piece of country is connected to the west with the Luni river, into which it drains. The difference in level between it and the river-bed is so small that when the river is in flood nearly the whole of the salt-pits are covered with water. The pits are rectangular in shape, almost 180 to 200 feet long by 80 to 100 feet wide and eight to ten feet deep. The subsoil water, which is very strongly impregnated with salt, fills them to a depth of two or three feet. As this water evaporates and is constantly supplied by fresh brine, the liquor in time becomes so saturated with salt that crystals begin to form. To facilitate their formation, and also to prevent the salt forming a solid mass at the bottom of the pit, quantities of thorny branches are thrown in, and the crystals form on these. A new pit is said to cost almost Rs. 1,500; it is allowed to stand for two years before any salt is taken out, after which a supply is obtained every year. To the north and west of the salt-pits nothing is to be seen but undulating sand-hills, following one on the other like waves of the sea; they are more or less covered with scrubby bushes and grass called bhurat. The seed of this is a most troublesome little burr, which clings to every thing in the shape of cloth that it touches. It is largely eaten by the poorer classes, who pound it with wooden clubs to clear off the husks, and then grind the grain for flour. In consequence of want of rain for two years, and flights of locusts during this last year, I was assured that in the smaller villages this grass seed has formed the only food of the inhabitants. Sweet drinking-water is the great difficulty. Water can be obtained almost anywhere by digging, but it is in almost all cases so salt as to be undrinkable even by the natives of the country, who can drink water which we should consider much too salt for drinking purposes. Even the river water is very brackish, although the water from temporary wells dug in the river-bed is often quite sweet. Balotra is entirely supplied from such wells, and yet the water from a masonry well on the opposite bank at Jasol is very salt. The river-bed is generally broad and sandy, but for some miles to the north of Sindri a good deal of rock crops up, and in one part it flows between almost vertical rocky banks, and is very narrow. From Nagar the delta (Nayar) may be said to commence. During the dry season running water may occasionally be met with for short distances, but as a rule the bed is either quite dry or at most has only pools of water in it.

Wheat is largely cultivated in the Nayar, and the soil yields excellent crops without any irrigation. Above the delta too, wherever the river water can be used for irrigating, good crops of wheat are raised. Grain is unknown as a crop, but it can nearly always be obtained from the dealers in grain, who import it. Beyond the reach of the river water, no cultivation except jowar in the rainy season is attempted. The water is raised from the river in the ordinary way by means of leather buckets pulled up by bullocks. The banks of the river being nearly always of a very unstable nature, it is necessary to support them in some way, so as to obtain a clear vertical pull-up. In the absence of stone, brick, or timber, they use small sticks and hurdle work, and line the wells below in a similar way to keep them clear of sand. In the richer country to the east, about Godwar, Erinpora, and Jalor, irrigation is entirely carried on from wells by means of Persian wheels. During November and December these wheels go on without cessation night and day, men and bullocks being regularly relieved. In order to ensure each pair of bullocks doing its proper share of work, a reel is fixed on the vertical spindle, and on some stationary portion of the machine is placed a second reel, which turns on its axis. On this latter is wound a certain amount of thread, the end of which is attached to the first reel and thereby becomes transferred from one to the other. When the transfer is complete, the bullocks are changed and the reels reversed. Five pairs of bullocks are used for each well during the twenty-four hours. To prevent the man driving the bullocks from going to sleep, and to let the man in the distant field know that the bullocks are at work, a loose piece of wood is so arranged as to clatter against the spokes of the wheel as it turns. This clattering noise can be heard all round at different distances from one's camp, and becomes rather monotonous and tiresome.

The country to the west of the Aravalli mountains gradually becomes more and more sandy as you proceed to the westward. Godwar, belonging to Jodhpore, immediately at the foot of the mountains, is particularly fertile, but west of this it soon begins to be sandy.

High jagged hills of bare rock, almost destitute of even the smallest vegetation, sometimes standing alone and sometimes in small ranges or groups, are met with until the Luni river is reached. To the west of this, except at Balmir, nothing is to be seen but sand-hills.

Extract from the Narrative Report of CAPTAIN G. STRAHAN, R.E., *in charge No.* 2 *Topographical Party, Khandesh and Bombay Native States' Survey, season* 1878-79.

THE triangulation embraces portions of the taluks of Bhusáwal and Jámner of the Khandesh district.

The chief rivers passing through this portion are the Kág, Kharki, Sur, and Wághur, all starting from the high range of hills separating this portion of Khandesh from the Nizam's dominions. The largest of these rivers, the Wághur, runs northwards, and joins the Tápti; the Sur and Kág join the Wághur a short distance north-west of Jámner.

Jámner, the chief town of the taluka of that name, is a large place on the left bank of the Sur river, and prettily situated between low hills. The chief places in the area triangulated are Jámner, Sámroda, Jamti, Nargaon, Pohar, Tondápur, and Fardápur, just outside the Khandesh boundary.

The country north of the Sur river consists of low hills rather thickly covered with babul, teak, and khair. Between the Sur and Kág it is also hilly, the greater portion being under teak forest reserve. To the south-west of the Kág the country is well cultivated, and consists of low undulating hills.

The well-known town of Ajanta is just outside the southern limit of the work. The famous Ajanta Cave temples lie about three miles south-west of Fardápur. It is a pleasant and interesting ride from this place.

Remarks on the country plane-tabled.

24. The detail survey on the one-inch scale comprised part of the Western Satpuras, embracing portions of the native states of Chota Udepur and Mathwár, north of the Nerbudda river; also Káthi, south of that river; and the Taloda taluka, in British Territory, the mountainous tracts of which are called Akráni. The Nerbudda cuts the north-west corner of standard sheet 30, from which it will be observed how extraordinarily straight the course is. The hills on either side go down to the edge of the stream, which is very narrow for the volume of water it must contain during the rainy season. The hills on the northern side of the river are very intricate and covered with jungle, which added to the difficulties of the surveyor, who says he never had such hard work before, as there was no portion of his ground over which he could ride. There is only one road crossing this tract practicable for camels, viz. that which runs from Pánwad to Kawánt and goes down to Háf, a village situated on the bank of the river and considered a holy place. There is a ferry at Háf, the only one for many miles on either side. South of the river there is a belt of rugged hills from 5 to 8 miles wide, rising to 3,337 feet, the bed of the river at Háf being only 289 feet. These hills are broken up into innumerable high peaks, consisting of huge rocks piled up, which appear a confused mass, entailing endless labour on the surveyor. Supplies had to be obtained from long distances, and those were of the coarsest description. The water was very impure, being full of decayed vegetable matter and minute insects, and to drink which without boiling was sure to cause an attack of fever. Even after boiling and straining it was far from wholesome, and Messrs. Barker, Graham, and George, who had the surveying of this inhospitable tract, were constantly suffering from fever, together with their klassies. The southern face of the Satpuras presented difficulties not usually met with even in such a tract. The average height of the range is about 3,000 feet, but there are several peaks between 3,500 and 4,000 feet above sea-level. Parts are quite inaccessible, and throughout the exertion one has to undergo in ascending and descending the spurs is excessively trying. Both Messrs. Pettigrew and Warde, especially the latter, who had this tract to survey, were frequently down with fever, and by the end of the season their appearance was so altered through hardship and fatigue that it will be some time before they are able to pick up again. Between the two ranges just described there is a high land, where the hills consist of comparatively low ranges, the valleys being productive and well-watered. Almost every acre of this tract, both hills and valleys, is under cultivation, where only joari, bajri, and paddy, which constitute the staple food of the country, are grown. The inhabitants are exclusively Bhils. Kathi, which is situated on this high land, is a moderate-sized village, the capital of the Mewas State of the same name. At the foot of the range, which comes to an abrupt termination, the ground is almost flat, and cut up with numberless watercourses, which run straight for miles, the smaller ones either losing themselves in the cultivation or joining the main streams. There is a belt of heavy jungle along the foot of the range, kept as a first class forest reserve, where no timber is allowed to be cut; then there is the second class reserve, where the jungle is less dense, and patches of it are under cultivation. All the country described, except the hills along the Nerbudda and the main range of the Satpuras, is covered with villages. The houses are all scattered, and every proprietor has his house on his own plot of land. To fix all these detached houses was a great task, and took up much time.

25. The country through which 2-inch scale operations were carried on, called the revenue-paying portions of Khandesh, consists of low ranges and groups of hills with intermediate plains. The hills have minute features, and therefore took longer to survey than those ordinarily met with. Parts are intricate and jungly and ill-adapted for a 2-inch scale survey, as the revenue is small and large tracts have been taken up by the Forest Department, much to the disappointment of the people, who are under the impression that they will eventually lose all their pasture lands. The river Tápti cuts the northern edge of the 2-inch scale work, and has several large tributaries to the south, some of which are bunded up in suitable places, whence the adjoining lands are supplied with water by means of irrigation channels. There are several towns and large villages in the plains and valleys, which will be described hereafter. There is one main road, viz. the old Agra and Bombay road, which is still kept under good repair by the local funds branch, and several district roads, which get terribly cut up and dusty as the hot weather approaches.

Forts.

26. The only fort deserving notice is that at Songir, a town situated on the Agra and Bombay road. It consists of a wall running along the top of a long, narrow, precipitous hill overlooking the town. Access to the fort lies at one point only. The wall is now falling into decay, and nobody resides in the fort.

41. Commencing from the eastern limit of the season's operations in the Satpura range, there is first the Anandbhoja Pass, over which the road from Shahada in Khandesh to Surat, *viâ* Dhargaon and Kathi, goes. After entering the hills from the Shahada direction, the road follows the course of the ravine, diverging here and there to avoid the turns, for about ten miles; it then ascends the crest of the Pass, which is practicable for lightly-laden camels, and with a small outlay could be easily improved. The traffic along this road is principally in timber, which Banjárás bring down for sale to Khandesh.

Passes.
Anandbhoja Pass.

42. This Pass lies to the north of Taloda, between the hills named Astamba and Satárábába. It is not practicable for camels, but donkeys and bullocks can go up laden. The road through this Pass runs from Taloda to Dhargaon, and thence to the Nerbudda, crossing that river at Háf, in the Chota Udepur State.

Chandseli Pass.

43. This Pass lies between the hills named Astamba and Sundra. The road which goes over it enters the hills at the village of Amli, the crest of the Pass being about a mile from Bir, in the Káthi State. The distance from Amli to Bir is 12 miles, but the journey must be made in two marches; there being a spot about half way large enough for two or three tents with an abundant supply of water. Within half a mile of the crest of the Pass, on the southern side, camels must be unladen and their loads carried up by coolies. Through this Pass lies the most direct means of communication between Nandurbar *viâ* Kukarmunda, where the river Tápti is crossed, and Kathi, and thence Háf to the north and Nandad to the north-west.

Amlibári Pass.

44. There is another Pass lying between the hills called Harás and Kumri, the entrance to which may be said to commence at a village called Bánoli, where the roads from Káthi and Dhargaon unite in plane-table 57. The road then follows the course of the river under Bánoli for about 10 miles up to the Nerbudda; it then turns sharp to the west, and goes along the southern bank of that river for about two miles, till the village of Bharar is reached, between which and Háf, on the opposite bank of the river, a small ferry boat plies. The only means of taking camels across is to place them between two rafts by means of ropes, letting their bodies swing in the water, and so assist them along; but it is rather dangerous work, as the animals generally begin struggling and capsize one or both the rafts.

45. The Agra and Bombay road is too well known to need any description: suffice it to say that it is kept in good repair, and connects Dhulia with Indore and Mhow.

Roads.

46. From Amalner *viâ* Betáwad, Sindkhera, Dondaicha, Ranála, and Nundurbár to Surat is a district road kept up by the local funds. It is hardly better than a country track, and in the hot weather is even worse, as it becomes very heavy. There is a good deal of traffic along this line.

47. From Dhulia *viâ* Songir and Chimtana to Dondaicha, where it joins the road above described, is a famine relief work constructed along the old track, but avoiding unnecessary turns. The old road is still used by traders, as the new one is incomplete in many respects. The traffic along this line is heavy.

48. From Sindkhera to Sarang Khera (where it crosses the river Tápti) and Andrud, where it divides off into branches, one going to Sháháda and the other to Taloda *viâ* Prakásha. The traffic along both these branches is principally in timber.

49. There are other minor roads communicating from village to village, and a reference to the standard sheets will give all the information that may be wanted. The hill roads have already been described under the head "Passes."

50. The Nerbudda cuts off a corner of standard sheet 30, and as much of it as comes within the season's operations is not navigable on account of its rocky bed.

Nerbudda River.

51. The Tápti flows through nearly the centre of the season's work from east to west; it is not navigable either.

Tápti River.

52. The Pánjhara enters the season's work in plane-table 70, flows under the town of Dhulia, passing which it takes a north-east course and falls into the Tápti under the village of Mundawad. It is not navigable, but there is water in it throughout the year, and many parts of it are dammed up, whence several irrigation channels take their rise and water the lands bordering either bank of the river.

Pánjhara River.

53. The Buray river enters the season's work from the west of plane-table 67 north-west, and, flowing under Chimtána and Sindkhera, joins the Tápti in the previous season's work.

Buray River.

54. The Amráwati enters plane-table 63 north-west, and, flowing under Málpur, Dondaicha, and Nimgul, falls into the Tápti.

Amráwati River.

55. Across the Nerbudda there is only one ferry, viz. that between Bharar and Háf, where there are a couple of little boats. From April to the commencement of the rains the river is fordable, there being from 2½ to 3 feet of water, but the bottom is rocky and unsafe for horses.

56. Along the Tápti the principal ferries are at Sárangkhera, Prakásha, Ashráwa, and Kukarmunda. The river is also fordable at these places from February to the setting in of the rains. At Sárangkhera and Ashráwa during such intervals the water is between 2 and

2½ feet deep, with a good hard sandy bottom; but at the other two places it is over 3 feet in depth, and consequently unfit for wheeled conveyances, except when the river falls very low, when it can be forded almost anywhere.

Inhabitants.

57. The same remarks apply to the inhabitants as those made in the previous season's report. No peculiarity in their manners and customs being noticed.

Products, soil, and cultivation.

These also are the same as those mentioned in the previous season's report.

Health of the party.

58. In consequence of heavy rains last year the Satpúras, as well as the low jungle tract lying at the foot of that range, were unusually unhealthy; and although no one entered those parts till February, when the climate is generally considered healthy, yet every assistant who worked there suffered more or less from malarious fever. The native establishment also suffered considerably. Guinea worm was very prevalent, and a number of men were rendered unfit for duty for months. Messrs. Graham and George are still suffering from an obstinate kind of fever, which leaves them for a few days and then attacks them with greater violence.

Topography.

59. The area which came under survey on the one-inch scale was the most intricate and difficult of any that has ever fallen to the lot of No. 2 party since the Khandesh and Bombay Native States' survey was commenced. It comprised the loftiest section of the Satpúras, the highest point of which, Astamba, attains an elevation of 4,346 feet above sea-level; and west of that point the range does not dip under 3,000 feet till after it passes the meridian of 74° 0′, when it falls away gradually. To the east of Astamba the range never falls below 3,000 feet till it enters the previous season's operations. Along the banks of the Nerbudda the hills are also high and rugged, especially the range to the south, which constitutes the northern face of the Satpúras, portions of which are quite inaccessible. Between the two ranges there is a high land very hilly, but the hills are comparatively low. This tract is covered with hundreds of Bheel villages, which are not in blocks, but consist of single huts scattered over the whole face of it. Every available spot, both hill and valley, is under cultivation, where only bajri, joari, and paddy, are sown, and which constitute the staple food of the country. From the foot of the Satpúra range to the river Tápti there is a wide tract of flat, rich country; about half of it is a forest reserve, and the remainder open and well populated. To the south of the Tápti, which is exclusively 2-inch work, there are extensive plains; after which the country again begins to get more and more hilly and intricate, till the southern boundary of Khandesh is reached. This tract has several rivers running through it, which join the Tápti. During the dry months there is very little water in them, but in the rainy season they are roaring torrents, impassable for hours and sometimes for days. The lines of communication are numerous, and the number of large villages which cover the face of the country show a degree of prosperity not often met with; yet it is said the people are very poor, to which state they must have been reduced through want of thrift.

Extract from the Narrative Report of MAJOR J. R. WILMER, S.C., *Officiating Assistant Superintendent, 1st grade, in charge No. 5 Topographical Party, Bhopal and Malwa Survey, season* 1878-79.

Country plane-tabled.

THE country met with this season was generally open and well-cultivated, except in the southern portions, where the Vindhya range crossed our work, and also along both banks of the Mahi river, which is intricately cut up with deep ravines. To the west of the Mahi river, where the triangulation was carried on, the ground drops very suddenly, forming a decided step on to the plains of Jhabua territory. This step runs northwards, breaking up into high hills. Just the outskirts of the Bheel country came under detail survey this season. The ground under triangulation was also entirely inhabited by them. I found that they were very tractable and willing to assist whenever one could catch them; but this was the difficulty, for on the approach of my party, or even a portion of it, the men would be seen deserting their huts and running off up the hill-sides, leaving their homes to be protected by their women and children. They are solitary in their mode of living, no two families ever living under the same roof. Their huts are made of bamboo, mudded over and enclosed by a stronger wall of bamboo. They build their huts from 100 to 200 yards apart, and their villages often extend to two miles in length. The men all carry bows and arrows headed with iron spear-heads. The Bheel Rajahs of Banswara, Jhabua, and Khandu, I found exceedingly hospitable and very willing in every way to help us. To the north-west of Amjhera, between that place and the cantonments of Sirdarpore, is the water-shed of India. The Mahi river has its source about here; the inhabitants say that a tank about a mile to the west of Mendha village is the real source, and its waters flow into the Gulf of Cambay. The station of Amjhera $\frac{\text{Lat. } 22° 32' 43''}{\text{Long. } 75° 11' 29''}$ is actually situated on the shed. The drainage within half a mile all round flows in every direction,—that to the west, as before mentioned, to the Gulf of Cambay; that to the south into the Nerbudda river; that to the north and east into the Chambal river. The height above sea-level at this point is 1,883 feet.

Passes.

The following were the passes met with of importance across the Vindhya range, and described by Messrs. Wainright and H. T. Kitchen.

Mohanpura Pass, known by this name throughout the neighbouring country.—The road from Dhar into Bhilpara, and from thence to Manawar, descends the main fall of the Vindhya range by this Pass. Locally it is chiefly used by grass-cutters and their carts, and owing to the frequent usage, is in very fair order and of easy descent. No jungle along the Pass. Water of a very inferior description below the Pass, and only during the early winter months. From Amjhera to Manawar, an easy descent and practicable to carts.—Water to be had in a stream half a mile north of Kesoi village in the winter months, but is almost dry during the hot weather. From Bhopawar to Gangwáni, also an easy Pass and practicable to carts.—Stream water to be had almost along the entire length. From Bhopawar *viâ* Tanda to Balwari, same as the other two passes in this work; but no water is to be had in the dry months.

Rivers.

The principal river, a portion of which was surveyed last season, is the Mahi, which takes its rise north of the Vindhya Range; and, as before stated, between Amjhera and the cantonments of Sirdarpore. Forty miles of the river was surveyed, which is not navigable, and can only be crossed in five places. Commencing at Sirdarpore, the ghâts are—

Between Sirdarpore and Rajgarh
„ Dasai and Rajgarh *viâ* Deola
„ Barmandal and Jaknawad *viâ* Kotra
„ Rajod and Pitlawad *viâ* Rajghat
„ Badnawar and Sarangi *viâ* Kesarbarli

} very rocky bed.

Products.

The products of the country are chiefly opium, also the usual cereals and sugar-cane. The country, where open and flat, is rich in soil, and when rain is favourable, produces excellent crops. Last season's outturn of opium was remarkably good, I was told; and in parts near Tarla, west of Sirdarpore, I noticed that the fields of corn were exceptionally good. Some ears of corn measured over four inches.

Extract from the Narrative Report of MAJOR W. F. BADGLEY, R.E., *Offg. Deputy Superintendent 3rd grade, in charge No. 6 Topographical Party, Khasia and Garo Hills Survey, season* 1878-79.

Plan of triangulation.

5. The triangulation had to be carried from last year's work southward, in the first place along two ranges—the Chátáchura, which forms the boundary between Sylhet and Cachar, and the Adam Tila, which runs parallel to it and west of the Langái river (there is an intermediate range, the Dewallia, but it disappears to the south); and in the second place westward, to the ranges west of the Adam Tila range. The work was based on sides of the last season's triangulation, and was entrusted principally to Messrs. Ogle and Chennell.

Nine hundred square miles of triangulation were finished, which carried this part of the work to the ranges running on about the same parallel as Sylhet, and providing us with sufficient data for (at our present rate of survey) the next two years. The triangulation consists of secondary, minor, and tertiary triangles, all the points of which are in the lines of hills in which our work falls. The points have been scattered rather thickly to suit the large scale of survey, except to the extreme north and south, where the difficulties to be contended with were more particularly great, but a sufficient number have been fixed for the plane-tablers even here. The stations were in most cases platforms supported by bamboo scaffolding round trees, the tops of which were cut off and the levelled stump used as a stand for the theodolite; these were sometimes 40 feet high. The results are much better than I expected, considering the roughness of the stations. Great care had to be taken not to touch the tree, as once set swaying it took some time to come to rest, and the wind for the same reason sometimes put a stop to observations. The minor points were nearly all large bamboo baskets on poles in high trees. No other points were to be had except at a few places where plantations have been begun, as except at these places the country is covered with forest, and is uninhabited.

Mr. Ogle, in trying to find the post marking the boundary between Sylhet and Hill Tipperah at Bongsoul, nearly encountered some Lushais, who were hunting near and whose shouts he heard, and Mr. Chennell found the deserted camp of other Lushai hunters on the Chátáchura range. The boundary mark (part of a telegraph post) at Bongsoul could not be found, though some time was spent over it, and though some of the Tipperahs (very kindly supplied by the Rajah's officials) who put it up went with Mr. Ogle; another post at Thangnag Peak was found trodden down by elephants.

Country triangulated.

8. On the Chátáchura range to the south and the Dewallia and Adam Tila ranges, about the latitudes of Adam Tila and Kulerai, where they have a moderate height, the selection of stations and triangulation generally was not very difficult; but to north and south, where they were lower, and in the hills to the west, which are so low as not to deserve the name, the difficulties to be contended with were such that one felt at times almost in despair of being able to do anything. The following are extracts from my assistant's diaries:—"Failed to secure a station anywhere about here, the country being low and the view completely shut out by high forest trees." "This tract is nothing more than a series of flat broad swells a few feet higher than the plain and covered with trees; many signals have been put up, but scarcely

any can be seen from any two cleared points within it, or even from the tops of trees, several of which I have ascended." The whole country, in fact, which comprises our work is uninhabited forest on wide tracts of low, much broken hills or swampy plains—the first very difficult, and the other impossible, to get about in. The selection of stations is most difficult work in such country, and is usually done in this way. From the last point cleared some point is seen which it is supposed will suit, and this is shown to the best woodsmen with the camp, who take the bearing, and by that wonderful faculty, which seems to retain for them the direction of the point aimed at, no matter what the windings of the way, lead across country never seen before and without compass, sometimes to the very spot. Arrived there or near it, men are sent up the highest trees to peer through their tops to find, if possible, the highest ground; and this, after repeated climbing, having been found, the most suitable tree for a station is selected, and the rest cut so far as they interfere with the view. All this of course takes time, and a week is not over the time which has to be allowed for a station, and this not including the return to the place for instrumental observation after the others round it have been cleared. Occasionally it happens that the surveyors find that no amount of cutting will clear the view, and then there is nothing left but to give it up.

The weather interferes much with the work both of triangulation and topography. In November a fog comes on after sunset and lasts sometimes till as late as one o'clock the next afternoon, and it is so heavy that the drip from the trees resembles heavy rain. These fogs continue till March, gradually decreasing in intensity. During March and April a thick haze, said to be caused by the smoke and ashes from the *jooms*, in Tipperah, interferes much with the triangulation; and the spring rains which occur in these months, though they clear away this haze for a day or so, do also interfere, not only as rain is usually inconvenient, but by resuscitating the insect pests of the forest, and, with the aid of fallen vegetation and increasing heat, breeding malaria in great quantity, render life in the forest a life of torment.

9. What I have said in the previous paragraph refers equally to this. The country is most difficult to work on in any way. It is particularly intricate, and every line has to be followed from end to end. One part of the surveyor's working time is spent in sketching the run of the higher ground from platforms in the tops of trees, and the other and greater part in chaining along the streams, and wherever he goes he has to cut his way, and progress is very slow. Where a chain line is run, the rate, as reported to me by Mr. Grant, was 30 or 40 chains daily, which he considers "very unsatisfactory, but unavoidable," as the men cannot do more, nor can they "take up any items beyond what are immediately on the line."

* Country plane-tabled.

10. There is a new stockade seven and a half miles in a straight line south of the old Chargola police outpost (now vacated), which is shown on the maps. It is on a little hill on the east bank of the Singla; and on the Châtâchura range, at the point called Roopatang or Hatchektang on the maps, on the boundary between Sylhet and Cachar, is a stockade occupied by the frontier police. They are built of posts, and are studded outside with quantities of bamboo spikes, and are intended for the protection of the inhabitants from attacks by the Lushais. There is a road, or rather path, between the old Chargola and Roopatang stockades, but no direct communication as yet, I believe, from the new stockade to Roopatang. If a path is to be made, a line east by south from the new stockade to the Châtâchura range, and thence north along it, would perhaps be the easiest.

Roads, rivers, inhabitants, &c.

There are no inhabited places in the work finished in South Sylhet except five small villages of Tipperahs—who have emigrated to avoid taxation in their own country and squatted in the hills on either side of the Chargola Valley—and eleven tea gardens.

In the flat ground in the middle of the valley there are several villages of Sylhettias, and to the extreme south of this cultivated tract and south of the old stockade some villages of Manipuries. These latter are included in the work, but the former, and the ground they cultivate, are out of it.

The Tipperahs are timid, pleasant-looking, active people, who, like all the hillmen to the south, are most excellent at jungle-cutting, going with a "ho-ho-ha-ha" chorus and bringing down a hill-side of bamboo like corn before a reaper. They are for this sometimes found of use and employed by the planters; but they are not beneficent cultivators, and therefore not desirable neighbours on lands which it is intended to take up for tea, on account of their using the *jooming* system of cultivation; that is, they burn the forest, which the planter would rather do for himself; exhaust the land, which is certainly not to his benefit; and then leave the place to be covered with grass, the extirpation of which is one of his great difficulties.

The Manipuries are pleasant spoken, independent, and ready to sell any thing; dead hands at a bargain, and sharp in most things except in the way they take up land, where they are being continually victimised in this way; they squat on some uncleared spot, clear it, and bring it into good bearing, but neglect to get a title to it. When the land has become valuable, a Sylhettia claims it, and either ousts the Manipuries or makes them become his tenants by threats of actions in the courts.

The Sylhettias are strong, cowardly, and morose, and quite uncompromising in their hatred to Europeans, whom they will never assist willingly even with over-payment, and would always injure if the opportunity occurred, as they have several times shown when a single unprotected unfortunate has fallen into the hands of a mob of them. Keeping the peace is sometimes very difficult, and occasionally one gets into somewhat of a fix. With several parties out in the jungles dependent on the head-quarters for supplies, the store-house

must not become empty, but more than once we have been near starvation, because the villagers drove our men from the markets and the landlords refused assistance. Several men were beaten during the season. Fowls, eggs, and milk, are to be had on payment from villages wherever I have travelled in India, except here, where without an order naming the landlord from the Deputy Commissioner nothing can be had at any price, though these common things are plentiful. Guides have to be brought in by the police.

Travellers of any sort fare but badly in this district; there is only one road, that between Chatak and Cachar. In other parts there are footpaths, which follow lines established by usage across the fields when the water subsides, and there are paths between and through the villages. These last are never used by strangers, who would be beaten if they attempted to enter a village, and the paths through the fields have to be opened yearly by the police. Travelling on the road on one occasion the people of a large village attacked my elephants and riotously rescued and carried off prisoners made by the police escort with me; threw stones at my tent, and I have no doubt applied all the choicest epithets of their very voluminous vocabulary of vituperation. The next week they rioted again, attacking some boats laden with treasure for the Cachar treasury. There is a bridle path across the Dewallia Range from Ratabari to the police guard on the Langai, and another between the old Chargola and Roopatang stockades. The first is almost, and the second quite, too steep for elephants. Communication is kept up on the other lines by footpaths, which serve their purpose moderately well in a country where there is no wheeled carriage, but would be much improved if along the principal lines at least some means were taken to make the streams and swampy places more passable to ponies and elephants. The footpaths through the forest are always in the low ground (where it can be managed) taken along streams, which have this advantage that their beds are usually firm sand, while the ground of the banks is muddy. The water is always chilly in comparison with the air, and splashing through it for long often brings on an attack of ague.

Of the streams the Singla river in the Chargola Valley is navigable for the smallest boats as far as the old stockade between (I think) the months of May and December. In the rains boats can go anywhere in the plains. I explored the Langai river in the next valley to about five miles from the Hill Tipperah boundary. It runs in the dry weather between high banks, and winds a good deal. It is narrow enough for a tree uprooted on one bank to fall with its branches on the other. Against these dams of drift wood are formed, which take a long time to cut through, and were so numerous when I went up that what took me six days going took only two returning. This river, however, will be reported on next year, when our survey of it is finished.

Extract from the Narrative Report of Lieut.-Colonel G. C. Depree, s.c., *Deputy Superintendent, 1st grade, in charge No. 7 Topographical Party, Rajputana Survey, season* 1878-79.

The character of the desert of Bickaneer is perhaps well known, yet, as the greater part of the country falling under the operations of this party during the last season is beyond the range of the ordinary tours of the Political Agent, and is a tract through which no travellers pass, I may be allowed to offer some notes on it. Commencing, then, on the north with degree sheet XV, which lies between the meridians 74° and 75°, and between the parallels 29° and 30°, the northern half of the sheet is made up of vast plains of sand mixed with some clay, in such proportions as to bind the surface together and to prevent the sand from being blown about; but at the same time the whole is so porous that rain water sinks as it falls, leaving a film of clay on the surface to harden, curl up, and crack as it dries in the sun, but no signs of any watercourses appear. Fully three-fourths of degree sheet XVI consist of similar level plains.

Over the remaining areas of sheets XV and XVI, and all of sheets XIII and XIV, clay is only found in certain depressions, and the sand exists only in a friable condition, capable of being moved by every wind that blows. In consequence, the surface of the country is a series of sand waves, which in some parts run in curiously parallel order. The maps of the season show these parallel ridges to have a direction nearly south-east and north-west, as they have been formed by the prevailing south-west winds which blow perpendicularly thereto. The northern face of these sand waves is always steeper than the southern, and the process of formation may be watched on any windy day. The moving sand is blown up the southern slope, and on reaching the summit is projected down the steep edge. These sand ridges, although they seem to be ever moving, must be influenced by counteracting winds, so that the absolute change of position must be very slow, for ancient temples of the age of a century (and there are no older buildings according to the natives) are still found preserving their original positions on the tops of hills instead of being half-buried in sand, or fallen, or out of the perpendicular, owing to the removal of underlying sand. Moreover, survey stations of late years remain as originally built, and trees and shrubs do not appear as overwhelmed with shifting sand.

In the northern half of the ground water is obtainable only in shallow excavations, or ponds filled by the rain. These dry up in February, and the people then begin to sink wells in the drying beds until they tap water. If they fail in this, they are obliged to leave their villages and retreat to others where the supply is not exhausted. While the water has lasted in these ponds, it has been the only resource of hundreds of camels and tens of

hundreds of cattle and sheep that twice a day resort to it, stir up the mud without any attempt at restraint by the villagers, and, further, contaminate it. The mixture thus formed is such that no person who had not actually seen it could believe in the possibility of a camp habitually drinking only such polluted water and yet retaining its health as mine did. After my experience of Bickaneer during the last field season, I find it difficult to acquiesce in the generally accepted belief that the use of impure water is the cause of disease.

But amongst the sand waves of the south the ponds cease, and wells are universal. In the direction of Churu and Bickaneer the people are better off, and brickbuilt wells are found in all the villages. It does not follow that these wells are all good drinking-water; one or two in half a dozen are fit for the consumption of human beings, and the others are more or less salt, and are used only for watering cattle. Of 48 wells measured by me in my wanderings, the deepest proved to be 337 feet, and the shallowest 57 feet. The drawing of water for so many cattle as the villagers possess is a laborious business, and seems to continue through the night and well into the day.

In the south also, besides the wells, masonry reservoirs are constructed like wells, but closed at the bottom, so as to hold the rain water, which is caught at the proper season by concentric platform areas made of mortar or beaten clay, which slope towards the centre. These reservoirs are called *tankas*: masonry domes are built over them, so that the water remains sweet, clean, and cool for an indefinite time, and it is doled out sparingly to a traveller with a *lota* and string passed through a small trapdoor, kept under lock and key.

Owing to the absence of natural elevations, the effect of mirage was most baffling, and the working hours of the triangulator were limited to one in the morning sometimes, and two or three in the evening. A curious series of phenomena were observed by me. During the previous reconnaissance it had been ascertained that the stations were mutually visible, so that the observer could count on obtaining his angles; yet he might wait in vain till two or three o'clock, when the heliotrope would appear as a halo, which gradually developed into a huge column of light impossible to be intersected. Later on, at the lower part of the column, a nucleus would begin to show, which eventually cleared and grew smaller until an object fit for observing would be visible; and it would continue with increasing clearness till a quarter of an hour before sunset, when suddenly, in a few minutes, an unaccountable change in the condition of the atmosphere would cause it to sink and disappear below the horizon.

The trees are very few and miserable. The *khejra* or *gant* is the most common, and as the leaves are good fodder, they and the young branches are systematically lopped, so that the bare stems yield neither shade nor beauty to the landscape. There are a few babools, called here *kikar*, and *ber* trees, and an occasional banian or *pipal* planted near a well. The camels might all starve though, if it were not for a plant with fronds like the stem of a rush or horsetail, which grows extensively everywhere in the desert, the name of which is *phok*. There is a common low-growing plant called *sarji*, from which fuller's earth or dhobies' ashes is made in large quantities. Coarse grass and the *madar* plant grow commonly, and there is a grass new to me, called *bhurat*, which has very prickly and tenacious seeds, but which yields a coarse, but edible, food-grain.

The whole country may be said to be cultivable, for it is only required to scratch up the sand, sow the seed, and the rainfall does the rest. *Bajra* and *moat*, a vetch, are the principal crops, and they form the only food of the people. The area of wheat is a mere trifle. It is said that when the rainfall has been good and the locusts do not destroy the standing crops, one year's harvest will feed the people for three years. Amongst the other crops grows a delicious water-melon called *mathera*. The crops are all off the ground by December, and after that till the next rains the Bickaneer cultivators remain idle in their houses. The absence of all vegetables is very trying to Europeans employed in Bickaneer, the inhabitants of which seem to require no green food.

The only remarkable forts are those of Bhatner and Anupgarh, which will be described when the detail survey embraces them and particulars have been fully obtained. Bhatner is now deserted, except by a few sowars and the tehsildar.

Extract from the Narrative Report of MAJOR H. R. THUILLIER, R.E., *Deputy Superintendent, 1st grade, in charge Mysore Topographical Survey, season* 1878-79.

THE triangulation executed during the season under report extended in a direction north-west and south-east along the boundary between Mysore and South Canara, from the parallel of 12° 30′ to 14° 0′, and for rather more than half the southern part of this distance it was carried eastward as far as the meridian of 76°, and as far as 75° 30′ in the northern portion.

The area embraced within these limits comprises a considerable portion of what is known as the Malnád of Mysore, situated in the districts of Hassan, Kadur, and Shimoga, the general character of which differs greatly from that of the rest of the province. It is difficult to conceive a greater variety of configuration of ground than is to be here met with.

Until the Malnád or highland region is reached, there is little variation in the appearance of the country, which is marked by innumerable undulations, with here and there hills rising up from them; but on approaching the ghâts the change is rapid and striking. The swells and hollows become chains of lofty hills, enclosing deep, and often narrow, valleys; while the

previously open and unobstructed view is now confined by the most luxurious growth of vegetation.

The main feature is the range of hills known as the Western Ghâts, rising in places to a height of over 6,000 feet, covered for the most part with magnificent virgin forest, and forming the source of numerous rivers and streams. The western face of this range is extremely precipitous, so much so as to render the hills in most cases almost inaccessible, in some instances quite so from that side. From the eastern face, however, numerous spurs branch out in all directions, forming more or less continuous chains of hills, which are again broken up into the most varied shapes and forms. The valleys, where space permits, are carefully cultivated, and are charming in appearance; while the combination of mountain and vale presents a picture such as only the most callous could gaze on without pleasure, and affords to the lover of scenery never-ending delight.

For the surveyor, however, whose duty it is to delineate the ground, the view must be regarded from a different stand-point. To represent the features of the country with fidelity, and to assign the proper positions on a map to all objects, whether natural or artificial, he must be able not only to see them, but also to a greater or less extent, according to circumstances, be able to see around him and to identify the points fixed for him by triangulation. This, it is feared, will very often be a far from easy matter; for though here and there the crests of the hills are clear of trees, in most cases they are covered, and nearly everywhere the sides and slopes are so thickly clothed with forest as to almost completely obscure the form and shape of the ground, as well as all features enclosed within their limits.

Owing to the broken, intricate, and confined nature of the country, all locomotion, except along the roads, which are here few and far between, is not only difficult, but slow; and when these roads are once abandoned, the only means of transport is by coolies or pack-cattle. The trade, in fact, between Mysore and the west coast is chiefly effected by the latter means. Off the roads it is rare that villages are met with, that is to say in a congregated form; the houses are broken up and scattered all over the land appertaining to the village, which may be extensive; each family builds near the fields belonging to it, in such situations as are found favourable for cultivation: hence there are generally a number of sites at wide intervals for what is in reality only one village. Owing to the forest-clad nature of the country, these hamlets and isolated dwellings are by no means easy to find, and the difficulties of the surveyor become much enhanced, both with respect to actual survey work and the collection of supplies and carriage. Coffee, betelnut, cardamoms, and pepper, are the staple products, and a large source of income to the people of the Malnád. The only other crops grown are rice and ragi in small quantities; and being chiefly for home consumption, the villagers are loathe to part with their small stores. It therefore often becomes necessary, when going into the more out-of-the-way parts, to carry supplies, not only for the establishment, but also for the pack-animals and coolies.

The Malnád (as the name signifies) is essentially the country of rain and fog, and it is probably due to the excessive moisture of the atmosphere that for the two or three months immediately after the monsoon season it is looked upon as most unhealthy for those who are not acclimatized to it; but from the end of December up to the end of February or beginning of March it is no worse than similar country in other parts of India.

The country topographically surveyed includes portions of the Bangalore, Kolar, Túmkúr, and Chitaldroog districts, and closely resembles that met with in other portions of the same districts which have been previously described.

In each sheet varieties of ground are met with: in some parts broken chains of wild, rugged hills, occasionally rising into lofty peaks some 1,000 to 1,800 feet above the surrounding plain; in others clusters of low, rocky hills, with ground much broken and scored with ravines, while portions consist of fine open undulating country, with magnificent chains of tanks.

The character of the hills met with differs, however. Those in the Bangalore, Kolar, and eastern part of the Túmkúr districts consist chiefly of gneiss and granite in irregular masses, presenting rough slopes, void of all vegetation, the sides generally being more or less covered with huge boulders of rock promiscuously piled one on the top of the other.

In the western part of Túmkúr, and in the Chitaldroog district (sheets 31 and 32), stratified hills make their appearance, running in parallel chains with rounded summits, moderate and even slopes, mostly stony and quite bare of trees, but having a green appearance in the wet season, from the long hill grass, which is the only vegetation that grows on them. The undulating ground met with varies considerably in elevation, the table-land of the Bangalore district being about 3,000 feet above the level of the sea. On the north and west a considerable depression occurs; the ground suddenly dips 500 feet to another undulating plain, extending to the Bellary and Chitaldroog districts, the general level of which is about 2,000 feet above the sea.

Extract from the Narrative Report, dated 22nd November 1879, *of* Lieut.-Colonel C. T. Haig, R.E., *Deputy Superintendent, 2nd grade, in charge Guzerat Party.*

The outturn of work in the field season consists of about 1,200 square miles of topography on the two-inch scale, and about 190 square miles of the Dangs survey on the four-inch scale; and about 2,200 square miles have been prepared with triangulation and traversing for final survey

The topographical areas comprise sheets 25 and 26 and the western half of sheet 5 on the two-inch scale (not counting about $\frac{1}{5}$ths of sheet 26, which was surveyed last year), and the completion of the Dangs forest, falling within the western half of sheet 49.

The half of sheet 5 surveyed comprises entirely Gaekwari territory, and is a flat, open country, with very little natural drainage; one insignificant stream, the Rupen, crossing the north-west corner; the rainfall being collected in tanks. There is one large town, Visnagar, with a population of nearly 21,000; two, Walan and Wasai, with populations respectively of 5,940 and 5,125; and 16 towns with populations ranging between 1,500 and 3,000, besides of course many villages; but as I have not been over the ground myself, I purpose leaving the full description of this area till next year.

Sheets 25 and 26 comprise portions of the Ahmedabad and Kaira collectorates, Gaekwari territory, Mahi Kanta and Rewa Kanta states, as follows:—

	Square miles.
Ahmedabad collectorate	235
Kaira ditto	73
Gaekwari territory	47
Mahi Kanta	450
Rewa Kanta	123

The territorial divisions are very complicated, particularly in sheet 26; and this is always more or less attended with delay in obtaining statistical information as to the correct mode of spelling the names of villages and as to their populations. In foreign territory inquiries, particularly as to populations, are always apt to be received with disfavour, as if we were inquisitive beyond our proper province, and refusals and delays are met with, giving rise to increased and tedious correspondence.

The following are the principal towns in this area:—Morasa, with a population of 6,728, on the Májam river. This is the chief town of the outlying portions of the British territory which are separated by the territory of the Edar State (Mahi Kanta) from the main portion of the Parantij taluka of the Ahmedabad collectorate, and it bears towards them almost the same importance as a taluka town. A "Mahalkari" here has his court, which is in most respects like that of a Mamlatdar, but for revenue purposes he is subordinate to the Mamlatdar of Parantij. It has also a police-station under a constable, and a school and a post-office, being on the postal line between Ahmedabad and Khairwara.

Harsol, with a population of 2,127, on the Meswo.—This is in the main portion of the Parantij taluka, and about 10 miles south-east of that town, and connected with it by a fair-weather road. It is also on the Ahmedabad and Khairwara postal line, has a post-office, and is connected with Ahmedabad by a fair-weather road. Formerly there was a military cantonment at Harsol, and the British Residency is still kept up, but only as a travellers' bungalow.

Kapadwanj, on the Mohar river, is the most important town within our operations this season. It is the chief town of a taluka of the Kaira collectorate, having a population of 13,290, with a Mamlatdar's court, police-station, Government school, and post-office, served from Mahmudabad, with which it is connected by a made road, the distance being about 16 miles south-west. There is also a considerable manufacture of country soap in this town, and a coarse description of glass is also made here, which is chiefly made into women's bangles, and a few glass-blowers make it into fantastic ornaments.

In Baroda territory there is the taluka town Atarsumba, on the Wátrak, with a population of 3,350; and Mándwa, the town of an Inamdar Thakur, with a population of 905, also on the Wátrak. In the Mahi Kanta the Thakurs' town Amaliára, on the Májam, with a population of 1,931, the station of the Assistant Political Agent, and a place of particular interest to this survey, as it was here that Lieutenant Gibbs died on the 21st November 1877. His tomb is in the Assistant Political Agent's compound, and in order to perpetuate the name in the records of the survey it has been "fixed" by a traverse, its co-ordinates have been computed, and it is permanently marked on sheet 26 as "Lieutenant Gibbs' tomb." Nirmála and Sátamba are also Thakurs' towns of some importance, having populations of 1,400 and 2,660 respectively.

The area embraced by these two sheets, 25 and 26, is well drained by the following rivers, running from north-east to south-west:—the Khári, Meswa, Májam, Wátrak Warási, Dhamni, Mohár, Shedi, and Mahi. The last named just crosses the south-east corner of sheet 26, and the first on the list just crosses the north-west corner of sheet 25. With the exception of the last on the list, all these are tributaries of the Sábarmati, and, excepting the Khári, first empty themselves into the Wátrak, which is a formidable river, not so much on account of the volume of its discharge, which is considerable, as on account of the reticulation of both its banks with tortuous and precipitous ravines, which make it a very formidable and obstructive feature both to the topographer and to traffic, which, south of the river, accordingly is directed to Mahmudabad and Nariad on the railway, and north of the river to Ahmedabad.

The rivers I have mentioned carry off the drainage from the watershed formed by the chain of hills running south-east from the southern end of the Aravalli range, and the nearer the approach to that chain, the wilder the country appears to become; and the whole of the eastern plane-tables of sheets 25 and 26 was very intricate and difficult, comprising a mass of low hills of about equal height, and lying mostly in parallel ridges, and being thickly covered with trees, it made the topography exceedingly tedious.

The country on the whole is finely wooded, the luxuriance increasing generally with the fall of the drainage; that is, the trees in the south-west are larger and of more luxuriant foliage than in the north-east, probably owing to the increased population and civilization, which eradicates the less valuable trees and substitutes the mango, tamarind, mowra, kirni, and other fruit-trees in their place. This abundance of timber, while affording delightful encamping grounds, makes the work progress slowly.

The climate this season in these parts was particularly good, and cases of sickness in the establishment were quite rare; but owing to the great drain on the resources of the country caused by the famine, prices were very high, and I was obliged to increase the pay of the klassies and peons Re. 1 a month all round.

The country surveyed in the Dangs lies partly north and partly south of the area surveyed the previous year. The Dangs have been abundantly described in previous reports, so I will not repeat needless descriptions now; suffice it to say that the area surveyed this year is as rough, wild, and unhealthy as any that can be found within this forest tract. Water was this year, however, very plentiful owing to the copious rains of last monsoon.

The surveyed area includes the whole of the made road from Gárvi to the boundary of Bánsda territory, on which there are three forest staging bungalows, viz. at Waghai, Pimpri, and Gárvi, and it is traversed by the Purna and Kháp̃ri rivers, and is bounded on the north and west by the Gira and Ambika rivers; the former lying in a very unhealthy valley. The Gira is an affluent of the Purna, and the Kháp̃ri of the Ambika, their respective junctions falling a few miles west of the Dangs.

The area prepared for final survey by triangulation and traversing comprises the east half of sheet 32, the whole of sheet 33, the western half of sheet 35, and the whole of sheets 16 and 17, which last two, however, only include about 345 square miles, as the rest falls in the sea, and an area of about 250 square miles in the Dangs in sheets 49 and 50. Besides this, the western half of sheet 34 has been triangulated, but yet awaits the traversing to lay down the village boundary trijunctions and other obligatory points for the incorporation of the Revenue Survey details.

There are three distinct claims which regulate the direction in which our operations must advance, viz. those of British and Baroda territory and of the Dangs. For the regular progress of the survey of British territory, of which special maps are published on the two-inch scale, in addition to the ordinary maps on the one-inch scale, I am aided by an Assistant Superintendent and an establishment of the Revenue Survey; and for their regular employment I must push on the triangulation over British territory in advance, so as to furnish them with starting and closing points for their traverses. We also are subsidised by the Bombay Government for the survey of the Dangs on the four-inch scale, which must also progress regularly; and we are also subsidised to the extent of Rs. 5,500 per annum by the Baroda Darbar on the condition of our turning out 550 square miles per annum till the whole is completed. These claims leave the officer in charge of the party little discretion as to the direction in which to advance the operations; and the area triangulated and traversed this season was chosen solely for the satisfying of these claims.

At the commencement of the field season I distributed my topographical parties with a view to the completion of sheet 5, as well as 25 and 26; but the surveyors in 25 and 26 found such difficulties in the eastern portions that on withdrawing the force to take up the work in the Dangs, these two sheets were in a very backward state, and I had to abandon the east half of sheet 5, and transfer the surveyors from it to the completion of 25 and 26.

Extract from the Narrative Report, dated 20th June 1879, *of* J. McGILL, Esq., *Officiating Assistant Superintendent, 1st grade, officiating in charge Kattywar Party.*

DURING the months of December, January, and February the surveyors were employed in the plane-tabling of sheets 51, 52, 53, 60, and part of sheets 58 and 59, all comprised in the Hallar Prant of Kattywar. The country surveyed is undulating, with here and there a prominent hill or small range of hills, intersected by numerous streams of water, and is remarkably bare of trees. The parts bordering on the Gulf of Cutch are marshy, consisting of mud banks stretching into the gulf, submerged at high tide, and islands of mud and sand intersected by innumerable little creeks, the surveying of which caused the surveyors very much exposure and fatigue, for the work had to be done in boats, which were of course dependent on wind and tide. These islands and swamps are covered with mangrove trees (a species of tamarisk), some of them rising to a height of 25 feet. In parts large droves of camels may be seen knee-deep in mud grazing on the leaves of the trees, and moving about apparently with as much ease as the camels of the desert move on sand.

Across the portion of Hallar, called by the inhabitants *Baradi*, passes the sacred highway of Kattywar. Thousands of pilgrims daily wend their way to Dwarka and Beyt *viâ* Nawanagar from all parts of India. Old men and weak women and children with swollen feet and heavy tread plod their weary way from village to village, receiving at each resting place the charitable dole of a handful of meal or a lump of dates; and after a few hours' rest shoulder their bundles and gourds and march on crying "Jai Krishnaji, Jai Dwarkanath." The wretched state to which these miserable beings are reduced from want and exposure is pitiable to see. Hundreds die on the way and are buried or burnt by the village authorities, or are thrown into the sea.

The only hill of any mark is Gope Gowar, an isolated, steep, scarp of basalt, which rises to a height of 1,191 feet above the sea; there is a small temple dedicated to Mahadeo on the top of the hill. Two villages, which lie to the south and west of the hill, take their names from it. The formation of the hills, except when bordering on Oka Mandal, are basaltic, with an understratum of sandstone. From Asota westward to Oka the hills are of ferruginous formation, mixed with laterite.

No rivers of any magnitude run through this district. The chief streams are the Wartu, Ghi, Sihan, and Fuljar; none of these has a course of more than 40 miles.

Water is obtained in abundance from streams and wells, and along the high roads wells are dug for travellers, with a stone trough alongside for watering cattle and a *visama*, or rectangular piece of masonry, for resting burdens on. These wells and *visamas* are built by charitable Hindus, and are characteristic of the country. Most of the towns and large villages have also *dharamsalas*, or travellers' rest-houses, with a well attached.

The chief towns of the district are Khambhália, Salaya, Bhed, Padana, Gunda, Miani, Deolia, and Lamba.

Khambhália is a large walled town and a pargana of the Nawanagar State. A wahiwatdar, a fouzdar, and about 60 police sepoys, remain here. There is also a post-office and two vernacular schools, one for boys and one for girls. The houses are large and well-built, and many bankers and merchants reside here. There is a travellers' bungalow to the south-east of the town, and some good *dharamsalas* for natives. The river Ghi flows to the west of the town, and a good strong dam is thrown across the river, which affords the people a plentiful supply of good water. On the west bank of the river is a large Mahomedan grave-yard, with some well-executed little mosques and tombs. The population of the town is 11,700, and comprises Memons, Banians, Ahirs, Sindis, and Kolis. The trade is dependent on the neighbouring seaport of Salaya. The exports are cotton, wool, and hides; and the imports sugar, grain, ghee, spices, dates, cotton cloths, and timber. Coarse cloths and blankets are manufactured here. Khambhalia has 128 villages subordinate to it.

Salaya is a small seaport town of 3,475 inhabitants on the southern shores of the Gulf of Cutch, which has a very safe and good harbour for vessels of 80 tons burden or under. A good trade is carried on with the Persian Gulf and various Indian ports. The river Ghi flows past Salaya, and its mouth forms the creek on which the tower is built. Salaya is subordinate to *Khambhalia*, but a fouzdar, a kamdar, and a few sepoys, reside there. The water-supply from surrounding wells is plentiful.

Bhed is a small town of 935 inhabitants, under the jurisdiction of the wahiwatdar of Padana. Vessels sometimes land merchandise on the shores of the adjoining creek. The water-supply is plentiful, and the inhabitants are chiefly agriculturists.

Padana is a small town and pargana of the Nawanagar State, with a population of 660 people, chiefly cultivators. A wahiwatdar, a fouzdar, and a small body of police, are stationed there. There is also a jail, a kutcherry, and a *dharamsala*. The water-supply from stream and wells is good. Padana has 58 villages subordinate to it.

Gunda is a town of 1,093 inhabitants, engaged chiefly in agriculture. The water-supply is very abundant. It is in the Bhánwar pargana of the Nawanagar State.

Deolia is a town of 1,305 inhabitants, chiefly agriculturists. It is in the Khambhália pargana of the Nawanagar State.

Lamba is a small town on the south-west seashore of Kattywar, with a population of 1,315 souls, who are chiefly cultivators. The sea lies about one mile to the south, and in fair weather vessels land grain and timber here. The water-supply is from wells. The town is in the Khambhália pargana of the Nawanagar State.

Miani is a small town surrounded by walls, and having a population of 689 souls, chiefly cultivators and fishermen. It must have been at one time a town of some importance, but is now nearly deserted and in ruins. It is a pargana of the Porbander State, and a fouzdar and some sepoys reside there. It has 12 villages subordinate to it. The water-supply is from wells. The Miani creek formed by the waters of the Wartu and Sani rivers flows to the west of the town.

By the 20th of February all the work that was triangulated in advance in sheets 51, 52, 53, 58, 59, and 60 was well nigh completed, and the European and native assistants were ordered to march to take up the plane-tabling of sheet 39 in the Gir jungle. The march occupied nine days, and by the 3rd of March most of the surveyors were at work in the boards allotted to them.

Owing to last year's drought, which caused the death of a large portion of the cattle, and this season's excessive rainfall, which made the country very unhealthy, the Gir was quite deserted, except in a few hamlets on its borders. The survey therefore of this dense and malarious jungle entailed a great deal of anxiety and trouble. The surveyors had to be provided with guides, carriers, guards, and provisions. Thanks to the willing aid of the native officials and careful arrangements on my part, I am glad to say that the survey of this difficult piece of country was successfully completed by the end of April, and the party marched to Verawal, on the sea coast, prior to embarking for Bombay. The heat of the sun in the Gir during the month of April was excessive, rising to 120° in a tent. Some idea may be formed from this of the hard work and exposure the European assistants had to undergo while working in this jungle. No roads could be found for carts or camels, and the surveyors had to content themselves with the shelter of a small *rowty*, and leave their tents and camp equipage at the nearest village. All the native surveyors suffered from fever; one has died since the arrival of the party in Poona, and two are now still suffering. Myself and some of the assistants were also attacked, but I am glad to say all have now shaken off the disease.

The country comprised within sheet 39 is almost entirely hilly, with here and there level ground densely covered with jungle. Frequent attempts have been made to establish villages in the Gir, and patches of forest have been cleared and huts built to induce people to settle, but the malarious climate has invariably driven the settlers away in despair. At Chelna, Surawao, and Moraka, wells were dug and comfortable houses built; but notwithstanding the richness of the soil and good terms on which land was allotted, the cultivators after a year's residence suffered so much from fever that they were compelled to abandon their houses and desert. Africans are the only class of human beings who thrive in the Gir forests, but they are chiefly wood-cutters and charcoal-burners. Previous to the last two years *Charans* and *Rabarees* were in the habit of camping in the forest for the purpose of grazing their buffaloes and cows—these temporary camps are called *nes*; but last year the grass failed, and numbers of cattle died of starvation or were killed by wild beasts and the starving Africans. Some of the hills in the Gir rise to a considerable height, such as Sarkala, 2,112 feet above sea-level; Lasa, 1,574 feet; Junderimal, 1,287 feet; Amla, 1,123 feet; Wasadhol, 1,072 feet; Rhainala, 1,055 feet; Kanara, 1,075 feet; and others of similar height. The formation of the hills is principally basaltic, with, in some places, an understratum of limestone.

The rivers Shetruji and Singaora both take their rise from the hill of Sarkala: the Shetruji flowing north-east through Kattywar, and falling into the sea at Sartanpur in the Gulf of Cambay; and the Singaora flowing south, and falling into the sea near Korinar. The Singaora and Hiran are the only rivers of any size which flow through sheet 39, but neither of them has a longer course than 70 miles. They are chiefly remarkable for their steep banks and rocky beds, and the brilliant green of the jambul trees that fringe their banks when all around is burnt up and arid.

Kattywar, as a rule, is a country very bare of trees, and this part of the province being very densely wooded, is called *par excellence* the *gir*, or forest. Its fastnesses are the resort of outlaws and robbers. Every petty *grassia* (hereditary landowner) who thinks he has a grievance against his chief, for which no redress is to be obtained, at once goes off into the *gir* and turns *barcattia*, or outlaw. There he soon collects kindred ruffians around him, and, awaiting a favourable opportunity, makes raids on villages or travellers, carrying off the spoil into his safe retreat in the jungle. To trace these marauders in a dense jungle, where there are no villages and no roads, is almost an impossibility.

The forest trees are the bar (*Ficus Indica*), pipal (*Ficus Religiosa*), umra (*Ficus Glomerata*), amli (*Tamarindus Indica*), neem (Azaderachta Indica), deora (*Cmocarpus Latifolia*), beli (*Ægle Marmelos*), kher (*Acacia Catechu*), babar kher (*Acacia Leucophlœa*), babul (*Acacia Arabica*), simal (*Bombax Malabaricum*), khakra (*Butea Frondosa*), sisam (*Dalbergia Sissoo*), dhaman (*Grewia tellafolia*), amla (*Emlica Officinalis*), karanj (*Pongamia Elabra*,) rita (*Sapindus Acuminatus*), rhone (*Soymida Febrifuga*), tembarwa (*Diospyros Melanoxylon*), mango (*Mangifera Indica*), kirni (*Mimusops Elengi*), bordi (*Zizyphus Jujuba*), jambul (*Eugenia Cariophyllifolia*), teak (*Tectona Grandis*), sojar, sarel, karamdi, saras, gorad, salora molera, kalaya, and many others. Wild hemp grows to a good height, and could be made a profitable article of commerce. Gums of many kinds are gathered in the jungle by the poor and sold to the banians for export. The teak grows very well, and large tracts are covered with this useful tree. A species of coarse grass grows to a great height in the low lands, and yields a small blackish seed, which is gathered by the poor and ground into meal for food.

There are only two roads by which laden carts can cross the *gir*—one from Verawal to Visawadar *viâ* Bholawat and Sasan, and the other from Korinar to Dhaoi *viâ* Gantwar and Dhalkania.

Extract from Descriptive Report of CAPTAIN H. S. HUTCHINSON, *in charge of* 11*th Revenue Division, Deccan Topographical Survey.*

2. Satara is picturesquely situated at the extreme east end of the Tás plateau, which is one of the high, flat ridges that break away eastwards from the crest of the Ghâts. The town of Satara lies close to the base of the plateau, in a valley between two spurs, on the eastern of which is the historical fort of Satara, and on the other the village of Enteshwar. On the Enteshwar spur a few houses have also been built as a sanitarium for the European residents of the cantonment. It is 1,664 feet above the city, is fairly well wooded, and possesses a delightful climate. A good description of the Fort of Satara, and an account of the historical events connected with it, will be found in "Grant Duff's History of the Mahrattas." The fort is in fair repair, but is completely commanded by the sister hill of Enteshwar, distant from it about 2½ miles.

3. The district of Satara, as far as yet visited, affords a marked contrast to the districts of Poona and Sholapur, in the evident care taken of trees, especially of those along roads, which have been carefully preserved, and which tend much to the comfort and pleasure of travellers. Several forts lie on the right and left of the road from Satara towards Mehmangurh Fort. In fact almost every hill in this country is crested with a scarp or precipice of from 50 to 70 feet in height, and in most instances these have been more or less fortified.

6. Pandharpur is situated in latitude 17° 41′ and longitude 75° 24′ east, on a sweeping bend on the right bank of the river Bhima. It is a pleasing sight from the encamping ground opposite the town to watch the ford of the river. Many hundreds of pilgrims in bright-coloured clothing daily come to bathe in the holy stream, whilst crowds are constantly passing from one bank to the other. Troops of devotees also, with their way-worn garments and sombre pilgrim flags, complete the scene, filling the air, as they march,

with discordant attempts at music, and shouting as they approach and depart from the holy city.

The following information relating to the city of Pandharpur is furnished by Mr. Smylie:—

"Pandharpur is the chief place of pilgrimage in the Deccan; thousands of people flock to it from all parts of India, especially in the months of April, July, and November, when the principal pilgrimages are held.

"The chief idol of the city is 'Vithoba,' the supposed incarnation of Vishnu. Hindoos attach vast importance to paying a visit to the city in honour of this deity, and bathing in the river. Its history goes back to 83 A.D., or the 6th year of the reign of King Shalliwahan, when it is said the people inhabiting the Dindurwan, which is described as a forest on the banks of the Bhima, about nine miles in length and breadth, reported to him that a gang of robbers, headed by Dalmajee Naik, greatly oppressed and plundered them; whereupon he ordered Ram Chandra Sadaseo Soni Oodawant to proceed to the place to punish the rebels, to cut down the forest, cultivate the land, enjoy its proceeds, and serve the deity Pandurang (Vithoba). Ram Chandra marched with four chiefs of the Koli caste, defeated and drove out the robbers, and inhabited the place. The present Koli inhabitants of the town are said to be the descendants of these four chiefs, and they still enjoy the privilege of plying their boats on the river for trade without any tax, and of collecting all the revenue of the temple of Pandlick.

"Pilgrims appear to have been attracted to the place since the time of the Peshwas, who came here annually with their sirdars and thousands of followers and spent large sums in charity.

"The houses, in number about 3,000, are thickly crowded in the central part of the town surrounding the temple of Vithoba, and are both badly drained and ventilated. The larger houses are square, built on cut-stone plinths of two or more stories, with thick stone or brick walls, having very few windows, and in the centre shafts from five to ten feet square open to the sky, which serve for the entrance of light and the exit of smoke.

"The chief source of water-supply till April 1873 was the river; but after the completion of the Tankli tank, formed by throwing a dam across the Tankli river, about a mile to the south-west, water has been brought from it to a large expense reservoir constructed close to the town."

Konkan.

The Konkan is the name given to the low-lying country between the coast and the Western Ghâts, varying from 20 to 15 miles in width. The tract is easily accessible from the sea by the creeks, which are often navigable by small boats to within a few miles of the Ghâts. These creeks, however, whilst affording the means of communication by boat, make land communications exceedingly difficult and circuitous. The country consists of low, flat valleys of rice cultivation, situated amongst hills of from 600 to 1,000 feet in height. These valleys have for the most part good roads running along their entire length, and leading from the principal places above to those below the Ghâts; but to cross the country in a north and south direction is exceedingly difficult on account of the deep water-courses of the drainage from the Ghâts.

The heat of this region is intense. The stagnation of the atmosphere amidst the hills, the radiation from the rocky face of the Ghâts, the want of verdure, all tend to give the Konkan a most unenviable climate.

AFGHANISTAN REPORTS.

Extract from the Narrative Report of MAJOR (*now* LIEUT.-COLONEL) W. M. CAMPBELL, R.E., *Deputy Superintendent, 2nd grade.*

HAVING reported my arrival at Quetta to Major Chapman, Assistant Quarter Master-General at Kandahar, I received instructions from him to proceed to Kandahar, and after a few days' delay, waiting for an escort, I started on 26th March with a convoy of convalescents proceeding to the front. On 30th March we reached Gulistán Karez, a standing camp at the northern side of the Pishin Valley, then occupied by the 3rd Sind Horse and a detachment of infantry.

On the same day the Commanding Officer received telegraphic information that the escort of Mr. Duke, Assistant Agent to the Governor-General on political duty in the Shorawak Valley, had had an engagement with the inhabitants, and it was thought that a demonstration in that direction from Pishin would have a good effect. A detachment was accordingly ordered to start next morning with that object, accompanied by Captain Wylie, Assistant Agent, Governor-General.

As the country to be marched through and Shorawak itself were quite new ground, hitherto unvisited and unsurveyed, I deemed it my duty to postpone the journey to Kandahar in order to go with the detachment. Captain Maitland of the 3rd Sind Horse, who had lately been appointed Assistant Field Engineer on survey duty, and deputed to assist Lieutenant Gore, R.E., in the survey of Pishin, also accompanied us.

Expecting rapid marching, I left some of my party and equipment at Gulistán Karez, and started light, with a view to running a compass and perambulator traverse, checked by

theodolite observations. Proceeding through the first portion of the Gwaja Pass to Spintaya camping ground, we there turned off to the left, or in a southerly direction, and skirting the edge of the desert we reached Poti, a village at the northern extremity of Shorawak, on 3rd April. Here we halted a day, having heard that the country people had quieted down since the fight, in which they had received a severe lesson, and their headmen had tendered their submission to Mr. Duke, who was then marching northwards in our direction. On 5th April we marched to Hisabat and joined Mr. Duke's camp. The purpose of the demonstration from Gulistán having now been fulfilled, Captain Wylie returned with the force to that place on 7th April, but I remained with Mr. Duke with a view to surveying.

He remained in the valley for some days, during which I measured a base line and did some triangulation, which connected my work with Takatu and Chiltan, two high peaks near Quetta, which had been previously fixed by Captain Rogers, R.E.

On the 18th April we left the Shorawak Valley and gained Chichizai, in the Shorarud district, by two very hard marches. At Chichizai, by measuring a short base and observing latitude and azimuth, and Chiltan peak, I obtained an excellent check on my traverse.

I separated from Mr. Duke in Shorarud, he going to Kalat while I proceeded to Quetta with the intention of using the newly completed telegraph line to measure the difference of longitude between that place and Kandahar. I reached Quetta on 27th April, having run a traverse the whole way from Gulistán, a distance of about 157 miles.

On 5th, 6th, and 7th May we had the use of the telegraph line, and obtained most excellent interchange of signals on the two latter days, but unfortunately both nights were cloudy, and prevented a very satisfactory determination of time at Quetta. Captain Rogers co-operated at Kandahar. I could not afford another day, because I had been instructed to accompany an expedition for the exploration of Toba plateau under Captain Wylie, Assistant Agent, Governor-General, who was then awaiting my arrival in Pishin. I marched accordingly on 8th May, and joined Captain Wylie at Alizai on 10th. Lieutenant Gore, R.E., joined us on the same day.

We succeeded in making an excellent survey of the country passed through, thanks chiefly to Lieutenant Gore, an artistic plane-tabler, and an energetic and enthusiastic surveyor generally. We marched through nearly the whole length of the table land of Toba, comprising the plateau of Toba and Tabin with the hilly tract between them, and then descended into the Kadanai plains, near Chaman, where we expected the party to be broken up. Captain Wylie, however, received permission to return across Toba by a new line, to complete his original programme, and we accordingly re-ascended from the north-west side by a new pass, crossed Tabin, and descended into Pishin on 2nd June, by a pass some 15 miles west of that by which we had gone up to Toba originally.

I had decided to remain in Pishin until Lieutenant Gore could produce a map of his plane-table work, which I might take to Kandahar with me; and I took advantage of the opportunity to procure another electro-longitude of Kandahar by means of the telegraph station at Gulistán. Captain Rogers again co-operated at Kandahar, and we got two good nights' work on 9th and 10th June.

On the 12th of June I started for Kandahar, taking with me a sketch map by Lieutenant Gore, including all the work then done by him in Pishin, our Toba survey, and the route traversed by me through Shorawak.

By the desire of General Stewart I proceeded to Kandahar by way of the Barghana Pass, some miles to the east of the ordinary road—a route which up to that time had not been followed by any of our officers, or indeed by any one attached to the army.

On arrival at Kandahar I took charge of the office and survey operations generally.

Our officers in Kandahar were Captain Rogers, R.E., Assistant Superintendent, 1st grade, Captain Beavan, R.S.C., Assistant Superintendent, 2nd grade, and Lieutenant Hobday, R.S.C., Assistant Superintendent, 3rd grade; besides whom the following Assistant Field Engineers were attached to the survey, viz. Captain Sartorius, Lieutenant Small, and Lieutenant Lake of the 59th Regiment, and Lieutenant Baynes of the 60th Rifles. Of the above, Captain Beavan and Lieutenant Small, assisted by sub-surveyors, were still employed in the field when I arrived, and Lieutenant Hobday had been obliged by fever to give up his field work.

In consequence of the continuance of cholera, a detachment of the 25th Punjab Native Infantry was ordered to march in the direction of Chaman on 16th August, and Major Chapman offered us the advantage of its escort with considerable independence of movement, and about a fortnight of extra time for surveying *en route*, as it was allowed up to 6th September to reach Chaman. Though the weather was still too hot for survey work in the field under ordinary circumstances, and the hot weather haziness of atmosphere continued in a remarkable degree, we were obliged to seize this the only opportunity likely to offer of adding to our survey results outside Pishin. Moreover, there had been symptoms of coming cold weather for some days before, which led us to flatter ourselves that the heat was over. Accordingly our whole force of surveyors started on 16th August, excepting myself.

At that time we looked forward to a *rendezvous* in the Pishin Valley, about the middle of September, and a concentration of our survey force on the intended return march to India by the Tal Chotiáli route; but all plans were upset on receipt of the news of the murder of the British envoy at Kabul.

When the 2nd Brigade, under Brigadier-General Hughes, was ordered to Kalat-i-Ghilzai, I received permission to accompany it, and left Kandahar on 23rd September.

While with General Hughes I was much hindered by want of men and equipment, as nearly all my establishment had been sent away with Captain Rogers on 16th August. Captain Sartorius of the 59th, who was also with the Brigade, was taken off ordinary regimental duty for the sake of surveying, and he was very good in giving his time to sketching, using the plane table I fortunately had with me. He had been at Kalat-i-Ghilzai the previous winter, when he sketched as much of the surrounding country as he could visit; and on this occasion he was able to extend his operations considerably, and continued at work until he was severely wounded in both hands when gallantly leading his men in the assault of the hill in the engagement at Shahgiri on 24th October. I obtained a good deal of triangulation of the country in which we were working and that in advance, which we were unfortunately unable to visit owing to the return of the Brigade to Kandahar. On the march back I succeeded in carrying a triangulation throughout the distance,—87 miles about,—from Kalat-i-Ghilzai to Kandahar, intended as a check on the position of the former place as previously determined by traversing. As we marched without a halt, and this work required each day the measurement of a short base, the determination of its azimuth (including observation for local time on all but one occasion) and horizontal and vertical angles at both ends, and generally at a third station as well, it was all I could do to execute it single-handed, and the results may suffer from the unavoidable hurry.

On arrival at Kandahar on 8th November, there seemed no prospect of any further employment for survey officers, so I applied for permission to return to my ordinary duties in India, which was granted by Sir D. Steuart, and I left Kandahar on 10th November.

Extract from the Narrative Report of CAPTAIN W. J. HEAVISIDE, R.E., *Deputy Superintendent, 3rd grade.*

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3. I ran a prismatic perambulator traverse from Quetta to Kandahar, checked by intermediate latitude observations at Gulistán-Kárez, Chaman, and Abdul Rahmán. The route we followed crossed the Ghazband range by a low easy pass about 12 miles from Quetta; thence across the Pishin valley to Gulistán-Kárez and Abdullah Killa (5,200 feet), where the ascent over the Kojak Pass may be said to commence. The ascent for the first ten miles was easy enough, lying up the dry open bed of the Kojak stream. About one mile from the top of the pass the bed of the stream contracts, becoming both steep and narrow; but although at this time coated with ice, a little picking and a few shovelsful of earth rendered it quite practicable for camels. Height 7,200 feet. The first quarter of a mile of descent was very steep, but the camels, some 400 in number, all got down without any mishap, and proceeded on their way to Chaman (5,500 feet) down the dry broad bed of another stream.

Kojak Pass.

4. The Khwája Amrán range is remarkably free from any well-defined points or peaks; it is better wooded than most of the ranges in southern Afghanistan, the beds of the streams being pretty thickly dotted with some sort of wild plum-tree, though on the hill-sides trees are few and far between. A characteristic of the Afghan ranges is a sort of glacis or curtain running the whole length, but generally only on one side of the range, sloping down at a regular angle from the foot of the range to the valley. In the case of this range the glacis commences about Chaman, sloping down nearly to the Kadanai river, or 1,400 feet in about ten miles.

Khwája Amrán range.

5. At Kandahar I found orders awaiting me to commence a survey of the country within a circuit of ten miles of the city. Before I could commence this, I was ordered to proceed to the Kadanai valley to survey there until General Biddulph's force was collected, and then to accompany him to India by the Tal Chotiáli route. I left Kandahar on the 13th of February.

My orders.

6. Kandahar lies in a valley which is about seven miles wide. The country to the north and east of the city is a flat, stony, plain, a goodly portion of which is covered with graveyards, and certain small portions show traces of being cultivated at some period of the year. To the west and south-west the land is thickly populated, with numerous villages surrounded and connected by a network of mud walls, orchards, and irrigation channels, with but few roads, and these narrow and tortuous, shut in by mud walls and more or less flooded by the field irrigation channels. In fact it was not at all easy to get about on horseback in this part of the country until one became acquainted with the roads. Wheeled carriage appears to be quite unknown; donkeys and very juvenile camels were doing all the carrying at this time, the adult camels having probably been sent down to India or sold for our transport. To the north and north-east of the city lofty, bare, precipitous hills, distant five or six miles, shut out any view in that direction. To the east the country is more open; the hills, though lofty, being far distant. To the south-east there is a low, short range, about eight miles distant, over which glimpses of the country and hills beyond are obtained. To the south and south-west the country is open; a few isolated hills stand up here and there, and the distance is bounded by the desert, which has the appearance of an elevated plateau.

Country round Kandahar.

To the west, four or five miles distant, there are sharp-peaked narrow ridges, a good deal broken up, which become even more isolated and broken to the north-west, forming there a wide open pass from the Argandáb valley, whence is led nearly all the water used in the irrigation of the land round Kandahar.

7. Kandahar itself is surrounded by high massive mud walls, the general outline being nearly rectangular in shape and rather more than a mile long, north and south, by half a mile wide. About three hundred yards from the northern end a massive mud wall is run across the city, forming this portion into the citadel, and keeping command of the gate to the north. In front of the main gateway which leads from the citadel through the centre of the city there is an open space, and a wide street runs straight away through the city to the south gate. This street is crossed at right angles by another street equally wide, running straight between the principal east and west gates. These streets, which are the only reasonably wide straight ones in the city from the main bazars, where they cross each other, the corners are rounded off, and the circus thus formed is roofed over and extended as an arcade for a short distance up the four streets. When we arrived at Kandahar the shops had only been open a few days, but we found the people already treating us as if they were used to us,—neither glad to see us nor displeased at our presence, and certainly ready to sell us anything. The Hindustani shop-keepers, of whom there were a goodly number in the cloth market, were more obsequious, and treated us to smiles and salams. The bazar, which was thronged all day, contained many very good things, though rather of the rough and useful, than of the delicate and ornamental, class. There were excellent cheap sheepskin coats (*poshteens*) and stockings; the latter were made roomy enough to go over any boots, and proved very comforting in the cold evenings, for at this period frost lay in the shade all day. There were the *chogas*, usually worn by the well-to-do Afghans, of the pattern which might be called sleeveless with sleeves, for the sleeves are mere flaps, into which no arm can go, and which can only be worn for ornament. These *chogas* were made of a capital close white felt, which appears to be a Kandahar *specialité*, and makes excellent caps and horse-clothing. There were old British uniforms of all sorts, fur-lined coats, a few inferior silk handkerchiefs, and Manchester goods in small quantities and expensive. The copper work in pots, pans, and drinking vessels, the iron work in agricultural implements, the earthenware in drinking and eating vessels, all showed more finish and more artistic merit than those of Hindustan; and the leather was better tanned than it is in India, though it was made up with the same weak sewing. But the feature of the Kandahar bazar as compared with those of Hindustan is the variety and quantity of the food offered for sale—fried trout and kababs, stewed fruit with curds, the Kandahar bread—an excellent light flat cake, very far superior to a *chapatti*—boiled beetroot, plenty of eggs, carrots, and water-cresses, pomegranates of a size and excellence I have never seen equalled, out of one of which half a tumbler of juice could be squeezed; while the stalls for the sale of almonds, raisins, dried figs, and apricots were as common as public houses are in London.

The city.

The bazars.

8. Kandahar may be said to be built of mud and sun-dried bricks, so little *pukka* is there about it; but it is built largely and solidly, and the effects of weather in such a dry climate take some time to make much impression even on mud. From outside the city the high massive walls appear to be in excellent order; and it is only when one comes inside and overlooks everything from the top of the citadel tower that the dilapidations become striking, and one comes to the conclusion that, with the exception of one or two mosques and one or two mausoleums, Kandahar is at least very much out of repair. A considerable portion of the city appeared to be untenanted, the population having probably migrated into the surrounding villages, which, if judged by the maps made in 1839, have very much increased in size and numbers in the last forty years. The citadel contains a palace built in the usual eastern fashion of courtyards, with all the accessories of stables, guard-rooms, barracks, magazines, gardens, and water-tanks. It was scarcely in better repair than the city, and but a small portion appeared to have been occupied just previous to our arrival. Some of the *zenana* rooms were in good repair, and the ceiling of one of these rooms was prettily decorated with bits of looking-glass inlaid amidst carved and painted wood work. There were many well-lighted underground rooms in the palace, generally facing the north, for occupation in the hottest weather.

Houses and buildings.

The citadel.

9. The old city of Kandahar lies about four miles due west of the present city, at the foot of a lofty range of rocky hills by which it was entirely commanded. It is now a deserted ruin—an example of the length of time buildings of sun-dried bricks will hold together in this country. About 600 feet above the site, on one of the spurs of the range, there is a brick fort, evidently intended to be the last stronghold, and close to it there are two large-sized catchment reservoirs, the brick arching over which is in places still standing.

The old city.

Survey in the Kadanai Valley.

10. The main object of the survey in the Kadanai valley was to extend a triangulation from Captain Roger's fixed points on the Khwája Amrán range across the Kadanai valley to the Hadah hills, and thence to fix some points to the north and north-west in the Arghasan valley.

11. The work comprised a measured base of about two miles in length, nine triangles, of which all three angles were observed, and a number of other points intersected. The azimuth of the base line was determined by observing two circumpolar stars at their elongations, and a good number of circum-meridian observations were taken to stars for latitude in case of a failure to connect with the Kojak points. Captain Holdich joined me at Spinbaldak on the 26th of February, and after laying down roughly the points I had observed, he was enabled to sketch in a fair amount of the topography of the valley, although, owing to the thick state of the atmosphere, the view of distant objects was much curtailed.

Captain Holdich.

12. The portion of the Kadanai valley chiefly dealt with lies to the north of the road from Chaman to the Ghetai hills. When we marched across from Chaman to Ghetai in January the aspect of the country was most desolate, and one would scarcely have supposed that anything but wild sage grew in the valley. But all this appearance had very much changed by the end of February. Numerous nomad blanket villages had sprung up in groups here and there, irrigation channels had been formed, and the whole surface of the valley was becoming green with grass and wheat. In riding about, too, one came across substantial and unsuspected villages hidden in the valleys which form the Khushobai tributaries. These villages were evidently prosperous, and near one of them I observed signs of vineyards and of cotton cultivation.

13. For the ascent of Hádah the camp was pitched at the village of Mulla Mustafa, the last permanent village on the northern branch of the Khushobai. The summit proved to be 2,000 feet above the valley, and the ascent with men carrying a theodolite occupied about 2½ hours. The first five or six hundred feet of the ascent was difficult, the route being over smooth, sloping surfaces of limestone rock broken into steps; but the higher we ascended the easier became the going, and the summit may be described as wide and rounded with a good deal of soil on it. The hill has in fact the appearance of having been heaved up pretty straight, taking with it a quantity of surface soil, and having its sides shaved in many places as by a razor. About 400 yards north-north-east of the station there is a magnificent cleft in the hill. Although not more than 50 yards wide, it has five precipitous sides, which cannot be less than 800 to 1,000 feet in height. The cleft does not extend through the whole width of the hill, but it is partially seen from the Shorandan Kotal near Kandahar, looking like a regularly cut gap in the hill. The chief vegetation met with was the wild fig-tree and a quantity of a close-growing prickly shrub, something like the English black thorn in character, though with a pink flower: the latter is a shrub common to most of the hills round the Kadanai. The Afghans, who acted as my guides, dug up many roots on the way, which they devoured. One tasted rather like a very hard Swedish turnip, another was decidedly mawkish and unpleasant. The only water on the hill was contained in a few pools left by recent rains, and the snow still lay in small patches near the summit. A fine view was obtained from Hadah, and several points about Kandahar were recognized. The city itself could not be seen, but observations were taken to the fort above old Kandahar, and to Baba Walli. The Hadah range—in most old maps is erroneously called the Ganti mountains, owing probably to some confusion with the name Ghetai—extends westwards from the station in one direction for about four miles, where there is a wide break in the range through which the Barghana road passes, and the range then runs on again to the Ghlo Kotal. In the other direction the range runs nearly north-east for ten miles, and then bends abruptly to the east and continues in comparatively low hills towards Nárin, forming the watershed of the two Khuhsobai streams, tributaries of the Kadanai.

The Hádah hills.

14. As to the geological features, the Hadah range and the Birdhak hills close to it are of limestone. Although limestone is not an igneous rock, there are, I think, traces of igneous action in the Hadah hill. The sloping beds of limestone previously mentioned are thickly studded with pebbles firmly embedded therein; and the fused edges of these pebbles, and of the limestone immediately surrounding them, lead one to suppose that they fell in a red-hot condition into the limestone, then of the consistency of mud. The Ghetai and Torgar hills are curious, being, as far as I know, the only granite rocks in the neighbourhood. The former, although I believe of true granite, have much the character of basalt. They take the form in many places of huge piled up boulder masses, and are evidently much weatherworn. One remarkable rock standing near the road is worn into almost a mushroom shape.

Geological features of the Kadanai.

15. Captain Holdich and I re-crossed the Kojak on the 6th of March by a capital wide road with easy gradients which had been recently made. The weather was simply atrocious during the march across the Pishin valley to Khushdil Fort, but with the aid of Takatu, Chiltan, and the Kojak points, a connected triangulation was kept up to this point. From Khushdil (5,100 feet) we marched nearly due east over the Suranari Pass (7,000 feet) into the Sarkhab valley (6,300 feet), encamping near Bolazai. The Suranari hills are composed of slate, the surface of which has much disintegrated. Two points on the range were observed from, one of which proved very useful subsequently.

From the Kadanai to the Sarkhab valley.

16. Bolazai was the rendezvous of the second and third columns of the Tal Chotiali force, and we fortunately halted there three or four days. This enabled us to measure a base, observe the three angles of one triangle, connect with the fixed peak Takatu and the Suranari station, and intersect a number of points, amongst others the snow peaks Kand and

The Sarkhab valley

Sarkand. On the 22nd General Biddulph arrived with the last of the force, and we subsequently moved with his head-quarters. On the 23rd I went on a reconnaissance with the General up the Sarkhab valley, reaching what is called the Metrazai Pass, the watershed of the Sarkhab and Zhob valleys. Our route lay for the first seven or eight miles up the open valley, and then entered the bed of the stream, following it up for three or four miles, where it had cut its way through some 10 to 20 feet of alluvium, until we emerged near the watershed (7,100 feet). Here the country had almost the appearance of a plateau, being wide and level between the ranges on either side, with two or three flourishing villages at the foot of the hills. We were able to look into the Zhob valley, but obtained no idea therefrom of its character.

Pass into Zhob valley.

The Tal Chotiali Route to India.

17. On the 24th the column left Bolazai to commence the return march to India, and reached Nahal Kot in the Kaho valley on the 8th of April, having marched 190 miles in 16 days. On the 14th we left Nahal Kot (Lugari Barkhan) with General Biddulph, arriving at Fort Munro on the Suleman range (6,240 feet) in four marches. It had been intended that Captain Holdich and I should return to Pishin by the Tal Chotiáli route; but this route did not remain open, and after General Biddulph's departure to India we remained at Fort Munro, employed in making maps and tracings and computing until the 12th of May. On that day we started for Ek Bhai Great Trigonometrical Survey station, about 16 miles distant, with a view to obtaining some check observations. We had to descend into the Rakhni valley (4,000 feet), and on the second day we encamped on the table land, some 1,500 feet below the peak, which is 7,460 feet in height. There was a fair path up to the peak, which we reached the next morning, and in the evening we were able to obtain observations to nearly all the points we wanted. The Suleman range is steep, and in many places precipitous towards the east, but between Fort Munro and Ek Bhai the top of the range is comparatively flat, and may be described as a series of plateaux and well rounded ridges cut into and split up by the drainage channels. The range is fairly watered at this season and well covered with coarse grass, but is utterly devoid of timber, an occasional wild olive tree pollarded to a stump serving to mark the fact more forcibly. There were occasional exceptions to this rule, and our camp below Ek Bhai was pitched by a streamlet trickling through thick masses of maiden hair fern into a pool sheltered by four or five good-sized trees, in which all the birds of the neighbourhood appeared to have congregated, and on the eastern slope of Ek Bhai there were a considerable number of Ilex trees. A few patches of cultivation were met with, and there is scope for a good deal more. Two little gardens kept up near Fort Munro by the Deputy Commissioner, in which grapes and nearly all the English fruits are successfully grown, show that the soil when well watered is capable of producing most things. We left Fort Munro on the 21st of May, reached Mooltan on the 31st, and Mussooree on the 6th of June.

Returned to India.

General Remarks.

21. The triangulation of the Tal Chotiáli route commenced at Bolazai and ended on the Suleman range. It was carried on during the marching under considerable difficulties. The route lay for the most part along valleys with high hills on either side. The rate at which we moved did not admit of our going far off the line of march, and between Bolazai and Khru, and the triangulation is chiefly kept together by acute-angled triangles to intersected points lying midway between short bases to which they were connected. The triangulation ceased at Khru, but our stay on the Suleman range enabled us to fix many back points, leaving eventually a break in the triangulation of only 33 miles out of a total direct distance of 170 miles from point to point. This is a better result than I could have anticipated in a country where there were no fixed points to assist us, and where from day to day we were in great uncertainty as to the route we were to follow on the morrow. The subtense theodolite (6-inch), which was used throughout, was invaluable in enabling the bases to be measured with rapidity; indeed at Chimjan a base could not have been measured without it. One of the ends of this base was on a range 800 feet above the valley, and the other end on some low irregular hills. As an example of what can be done with this instrument in one day, I may mention that at Nimgan, after marching ten miles with the column, a base was selected and measured, observations taken from the two ends, and an azimuth observed at night in showery weather. The azimuths of all the base lines I measured were determined by circumpolar star observations, and without a good determination of azimuth base lines even for work of this character are of little value. In addition to star observations for azimuth, time and circummeridian observations for latitude were taken at Bolazai and Chimjan. At Nimgan the night was too cloudy for stars; but as from this point we were in some uncertainty whether the triangulation would hold together, four or five stars were observed nightly for latitude at each halting place (except Hankua, where the sun was observed) from Uriagai to Lugari Barkhan, inclusive.

The triangulation.

Astronomical observations.

22. Captain Holdich made a plane-table sketch of the whole route from the Kadanai to the Suleman range. Two native surveyors also assisted us—one, Emam Baksh, generally known as the Bhozdár, from the tribe to which he belonged, carried a plane-table and perambulator traverse along the route followed by the column, sketching in the hills in the immediate neighbourhood; the other, Abdul Reshul, traversed the same route with a prismatic compass and a second perambulator. It has been mentioned that Captain Holdich only joined me towards the close of my survey work in the Kadanai valley, up to which time I had been working alone. This was unfortunate, for my time was so entirely occupied with the triangulation that I had no time to devote to topography, and through the want of a second officer several valuable opportunities of sketching were lost. The advantages of having two officers associated together for work of this character, one of whom does the triangulation while the other sketches the topography, are enormous. Indeed, had there been but one survey officer with the Tal Chotiáli force, the rate at which the force marched would have rendered it impossible for him to produce more than a plane-table sketch and traverse of the country, unchecked for 130 miles by anything better than a few astronomical latitudes.

Topography.

23. The general characteristics of the features of the country of southern Afghanistan are bare, rocky ranges and wide open valleys; so wide and flat are the latter between Quetta and Kandahar, that they appear more like plains than valleys. The ranges are so broken as to offer easy passes in every direction. The passes moreover are remarkably easy, as may be gleaned from the description of our march down the Tal Chotiáli route, which led generally through a mountainous country over several passes, one of which is 8,500 feet high. Although long marches were made, yet the camels surmounted these passes without much difficulty, and, with one slight exception, without any manual labour being bestowed on the track, which for a considerable portion of the route may be termed unfrequented.

Features of the country.

24. The scarcity of trees throughout the country is appalling. A wild plum-tree and the juniper are found growing to a fair size on some few of the ranges. Round many of the villages there are a few orchards and an occasional fair-sized mulberry-tree, but otherwise there is not a stick of what could be termed timber.

Trees.

25. The villages in the neighbourhood of Kandahar all contain a certain number of small-domed buildings, built close together in a row, and having the appearance in the distance of gigantic beehives. These are probably comfortable dwelling-places, cool in summer and warm in the winter, and being constructed entirely of mud, are well suited for a country where there is no timber. In the Bori and Kaho valleys the villages are generally surrounded by a high mud wall flanked by towers, which completely conceal the houses. There is a large nomadic population in southern Afghanistan, chiefly pastoral, who live in huts formed of blankets stretched over withes. Half the hut is usually devoted to the sheep, in the other half two hollows are formed in the floor, one for the fire, the other for milk, and a little mud platform is erected about a foot and a half high, neatly paved with pebbles, for the water skin to rest on. In winter these huts are chiefly met with in small sheltered valleys amongst the hills, but in the spring groups of them are seen dotted about the larger valleys, and the occupants commence systematic cultivation.

Villages.

Nomadic population.

26. Notwithstanding the small rainfall, the country is well watered. This is not so evident on the surface, but there appeared to be in most places an underground flow of water, and this is tapped by means of shafts and tunnels forming underground canals termed *karez*. Great labour is bestowed in making these, and they are so numerous, and are so often found in out-of-the-way spots far from habitations, that one is apt to think the people must sometimes make them for amusement. Such spots have probably at some time been occupied by the nomadic part of the population in search of virgin soil, whose motto is—"Take as much from the soil as you can get; never return until you are obliged." The water throughout Afghanistan is more or less impregnated with alkalis, generally of an aperient tendency; and wherever there is water, there is a white efflorescence on the damp soil. The only exception I noticed was in the water of the Argandab, which flows in the canals round Kandahar.

Water and irrigation.

Karez.

27. We saw very little game. The large sand grouse was plentiful in the plains, and not so wild as they are in India. An occasional *houbara* was shot, and *chikor* were plentiful in the higher ranges. Beasts were scarce. On the Khru mountain we saw a good number of wild sheep, something like, but smaller than, *ooreal*, and on the Suleman range *ooreal* and *markhor*.

Game.

28. During the whole course of our survey operations we were never molested by the enemy. We were fortunate in serving under Generals who took a keen interest in geography, and were ever anxious to extend our knowledge on this subject, while at the same time they furnished us with ample escorts for the execution of our work. To these circumstances may be chiefly attributed our success in mapping some 5,000 square miles of a new country, of which 3,000 square miles were executed when marching through an enemy's country at the average rate of 12 miles a day, with some of the marches over 20 miles in length.

Escorts.

Results of circum-meridian observations and those to Polaris for latitude taken on the Tal Chotiáli route with 6-inch subtense Theodolite No. 18, by Troughton and Simms.

Station of observation.	Mean latitude.	Probable error.	Remarks.
	Deg. Min. Sec.	+ / − Sec.	
Khushdil (camp)	30 41 8	12	
Bolazai ,, ...	30 37 55	8	
Chimjan ,, ...	30 33 50	6	
Uriagai ,, ...	30 23 56	7	
Shoran ,, ...	30 24 36	8	
Anambar ,, ...	30 21 24	10	
Trekh Kurram ,, ...	30 13 44	4	
Chamalang ,, ...	30 8 56	7	
Baladaka ,, ...	30 2 37	6	
Hankua ,, ...	29 56 14	.....	There is no determination of probable error for the value of Hankua, as only one observation was made.
Lugari Barkhan or Nahal Kot (camp)	29 46 23	5	

These values support the triangulation, except as regards the position of Shoran, which is placed a mile further to the north by the triangulation than by the astronomical values, showing that the points Khru Peak and Bluff Peak of the Nimgan triangulation are probably too far to the north.

Extract from the Narrative Report of Captain M. W. Rogers, r.e., *Assistant Superintendent of Survey.*

* * * *

On the side of the Gwája pass I ascended Khwája Amrán, the highest hill of the range, and the one from which it derives its name. Its height is 8,853 feet; the ascent is long and difficult. On the summit there is a large grave-yard, in the centre of which is the tomb of the "Saint Khwája Amrán," 45 feet in length, that being the height of the holy man. The story told is that he died in a distant country, leaving orders that his body should be tied on his favourite camel and buried where he stopped, which was on the summit of this mountain. The graves around are those of rich and influential men, who were able to afford the cost of transport to the top of the hill.

* * * *

The country on the Kandahar side of the Khwája Amrán range as far as Kandahar is a vast plain, sloping gradually to the north and west. It is dotted with many isolated hills and small parallel ranges running north-east and south-west parallel to the Khwája Amrán range.

Numerous hot-springs met with point to the volcanic origin of the country. One in the foot of Kalát-i-Ghilzái issues at a level of 300 feet above the surrounding country, and its temperature in January was 79°.

The plain is bounded towards the west by a vast desert; it is drained towards the south by the Kadanai and Kushdhai rivers, both dry in summer. These run into the Dori, with whose source I am unacquainted; a perennial stream apparently, forming the eastern boundary of the sandy desert. The Dori is joined on its right bank first by the Arghestán, next by the Tárnak, both dry in summer, and falls into the Arghandáb, which is a perennial stream, and falls into the Kelmand at Kala-Bist, 40 miles below Girishk.

Of the Arghestán I know but little. Near its junction with the Dori it has a broad shallow bed, and when I crossed it in winter there was but a small amount of water.

The Tárnak in winter has a good volume of water in its upper course; its valley is about ten miles wide, with high hills on either side nearly continuous on the north. The valley is a succession of low rolling hills, which come down near to the river on each side, and through which, near Kalát-i-Ghilzái, has hollowed a winding course with precipitous banks. In January there was in it a considerable amount of water, and I believe that the upper course is never dry; but long before it reaches the neighbourhood of Kandahar most of the water is taken off for purposes of irrigation.

The Arghandáb is a much larger stream than either of the others. At about 90 miles from Kandahar, at the highest point I reached, it was a deep rapid stream about 100 feet wide (in February), with indications on the banks (which were rocky and precipitous) of a rise of from 10 to 15 feet in flood.

In this upper portion of its course it runs through very mountainous country, the hills in many cases descending sheer into the stream, preventing the possibility of following it during its entire course. The country is thinly populated and the villages are small, situated generally on the small streams which flow into the main river. These streams are much used for irrigation, and in the narrow valleys through which they flow every foot of ground is cultivated.

The road by which the column marched from Kalát-i-Ghilzái to Kandahar is rough and bad, fording the river twice, and continually crossing the valleys of the side streams, keeping about four miles from the main stream, along which there is no path possible. It would be very difficult, if not impracticable, for wheeled artillery. The banks in most places are fringed with willows, and there is along its course some of the only pretty scenery I have seen in the country. The stream is strong and rapid, and the fords are few. At about 30 miles above Kandahar the hills recede and the country becomes open, and the river widens considerably and runs in many channels.

Twelve miles above Kandahar, on the left bank, a large canal is led from it, which runs parallel to and near the river, and provides the main water-supply for Kandahar and its valley.

Along the course of this canal, on both sides of the river, there is a continuous succession of villages, gardens, and orchards, which form a most pleasing contrast to the rugged, barren mountains which separate the valley from the Kandahar plain.

The Khákrez valley lies to the north-west of Kandahar, and is higher than, and drains into, that of the Arghandáb, from which it is separated by a range of low hills, in which there are many passes. Its elevation is from 4,500 to 5,500 feet; and it is separated from the parallel valley of Ghorak by the Shah-Maksud range, which are the highest hills in the vicinity, some of the peaks being 9,000 feet above the sea.

There are several large villages and a good deal of cultivation in the Khákrez valley, which, however, has no running stream, but only large dry *nullahs*, which carry off the water in rainy weather, draining into the Arghandáb near Khushki-Nákud.

Extract from the Narrative Report of Lieut. St. G. C. Gore, r.e., *Assistant Superintendent, 3rd grade, Survey of India.*

On arrival in Pishin on the 18th February I found that Major Sandeman, Agent, Governor-General, was at Kandahar, and was not expected back for a fortnight. Pending his arrival I employed myself in reconnoitring the country in order to see the best way of undertaking the survey.

On Major Sandeman's arrival in Pishin I marched to meet him, and settled with him as to the composition of my native establishment, and as to the entertainment of the necessary men.

Scale of survey.

After discussing the requirements of the political officers, I decided on commencing a survey of the Pishin Valley with its bordering mountains and communications, on the scale of two miles = 1 inch.

I was, however, delayed some time owing to a difficulty in providing me with a permanent escort, there being very few troops in Pishin at the time.

I employed myself meanwhile in measuring a base line across the valley, its western end being situated near Gulistan Kárez, and in determining its azimuth by astronomical observations. The length of the base line measured plane-tabling was about 4½ miles.

On obtaining my escort I commenced the survey proper, carrying on the plane-tabling and triangulation simultaneously, in order not to have to re-visit the same ground.

Initial data.

The initial latitude and longitude were obtained by observations to a hill peak north of Quetta (Takatu No. 4), previously fixed by Captain Rogers, the distance to which I fixed by triangulation from my base, and the azimuth of which I fixed astronomically. I may here mention that since the completion of the triangulation by me, the triangulation brought up from India has been extended to Pishin, giving me true values of latitude, longitude, azimuth, and linear distance with which to correct my triangulation. The slight errors in the two latter elements will not, however, affect the mapping, which has been completed.

Pishin work resumed.

On my return from the exploration of Toba, on 3rd June, I resumed work in Pishin, though the weather was very unfavourable owing to the heat and haze, and continued at work until the 4th July, when, at General Stewart's request, I marched for Quetta to join Captain Showers, 1st P. N. I., in a reconnaissance round the east and north boundaries of Pishin.

Completion of Pishin work.

From this point, on the 31st August, I again took up the survey of Pishin, working along the Khwája Amrán Range and examining the passes. I then worked my way to the head of the valley, and thence round to Quetta, completing the work on the 15th October.

I have been much assisted in surveying the more open parts of Pishin by Sub-Surveyor Saidulla Khan, who has worked well.

Area of work completed.

The outturn of work on the scale of 4 miles = 1 inch is 2,000 square miles on the Toba plateau and the Kadanai river, and 960 square miles in the Kákar country, making a total area of 2,960 square miles on that scale.

On the scale of 2 miles = 1 inch an area of about 1,600 square miles has been surveyed and mapped on a strictly trigonometrical basis.

On the 13th July our party, under Captain Showers, 1st P. N. I., consisting of an escort of 200 men under Lieutenant Fasken, 2nd Sikh Infantry, Captain Showers and myself, left Quetta and proceeded, by an unexplored pass lying to the east of Takatu mountain, northwards towards Amádun. The road for the first seven miles passed across the Quetta

plain. It then entered the hills and ran up the Sarakula nala— not very narrow at first, but getting gradually more so. A plentiful stream of water was running down the nala. The second day we continued up the stream, the road being a little difficult for camels at one spot owing to fallen boulders, until the watershed was reached at a height of 6,820 feet. Our third march, which lay through rather more open ground, took us by the Ushlakhai pass over the main watershed at a height of 6,263 feet. This is, as far as I know, the lowest pass over the watershed, dividing the Indian from the Afghan water systems, to be found anywhere in these parts. Unfortunately the pass is not of much use, as beyond there are much higher minor passes over spurs and such like, which render the roads leading from it towards India difficult.

Our fourth day's march took us to Amádun, a fine village inhabited by Kákars with a few Tarins. The village is prettily situated in terraces on the high ground, at the foot of a curious wall-like range of hills called Bibai, reminding one greatly of a Himalayan village.

After a few days spent at Amádun, we determined to explore the Kawás valley, a region hitherto unknown to Europeans. Leaving Amádun on the 20th July, we marched up a small valley to the ridge (height 7,343 feet) joining the Bibai hills to the large mountain pass of Pil on the south. Thence there was an easy descent of some 2½ miles to a small village of Wám, where we camped.

The next day, taking an escort, I ascended Pil, not without a certain amount of opposition from the Kákars living on it. The weather unfortunately was rather hazy, as otherwise I should have had a splendid view, the height of the hill being about 9,300 feet.

The country about here is very different from that seen in the Pishin and Kandahar direction, the hill-side being very well clothed with *juniper* trees, growing straight, and up to 30 or 40 feet in height. Coming down the hill, I made my way into Kawás.

The Kawás valley is well watered and well cultivated, and when we were there, there were plentiful rice crops springing up, maize and lucern being also grown.

The village of Kawás itself merits notice. From a distance it looks like a fort with a wall round, and rising higher in the middle than at the sides.

When one gets closer, one finds that what appeared to be a fort wall is nothing more than the outer walls of the houses, which are all built close together with no streets intervening. There are small apertures in the wall here and there, which serve as entrances, the inhabitants having to pass from house to house until they reach their own dwelling. They seem to live a good deal on the roofs of the houses, as I saw several women going about their daily occupations in that position. We were invited to explore the town, but knowing the character of our hosts, declined.

The most curious feature about the conformation of the country is the way that all the hill ranges, here composed of limestone, run east and west, while the direction of the main stream is north and south. This river, which forms the head water of the Nári river, which drains from Sibi, in less than 20 miles bursts through three mountain ranges. The external appearance of the ranges evidently shows that at some period they were continuous, but they seem to have been reft open, and the river now finds its way through. The cliffs on either side of these gorges tower up from 400 to 800 feet, and the bed, which is only some 40 feet wide in places, is greatly blocked by fallen boulders. Indeed, in the centre of the three gorges the bed has been absolutely blocked, apparently by a landslip, and a long narrow lake has been formed, extending for a mile or two along the bed. The inhabitants have it that this was the work of a fakir 75 years ago, who, being displeased with the people of Mángi, situated a little lower down the river, for their want of due respect for him, determined on cutting off their water, and dropped a piece of a mountain into the gorge.

The upper of the three gorges is the only one passable, and even it is greatly blocked up.

The mystery of "Mount Chapar" was at last discovered. It has always figured as a mountain on the maps, and yet no one could ever see it.

It now turns out to be not a mountain at all, but a low spur of a range of hills. Owing to the narrowness of the defile through which the river passes, the third of the abovementioned gorges, the only road which leads from the Amádun country in the Sibi direction, is forced to leave the river bed and pass over this Chapar spur. The road up is steep and difficult, the height from bed of nala to the top of Chapar being 1,160 feet, and the absolute height of the latter 6,680 feet. This being the one obstacle to the use of the road, is always brought prominently forward when one enquires as to the routes, and so has no doubt acquired a fictitious importance and been magnified into a mountain.

From Kawás a valley leads eastwards, up which a road passess over the Ziárat Kotal to Smálen, and thence to Tal Chotiáli. The pass is however high, and a good deal blocked with snow in winter. Deodars were found growing in one place along this road—the only instance I know of their occurring in this part of the country.

From Kawás we made our way northwards *viâ* Zargai to the Tal Chotiáli road, previously traversed by the force under General Biddulph, striking it at Dukán Kach. This ended the reconnaissance of the unexplored Kákar country, which happily, with the exception of an attack on the camp by fanatics at Dukán Kach, passed off without active opposition.

Extract from the Narrative Report of Lieut. J. R. Hobday, *Assistant Superintendent, 3rd grade.*

On the 15th December 1878, whilst on furlough in England, I received a telegram ordering me to join the Quetta column immediately, and in compliance therewith started on

the 25th of that month, and arrived at Bombay on the 15th January. Proceeding thence *viâ* Kurrachee, I arrived at Quetta on the 18th February, where I found orders from the Assistant Quartermaster-General to proceed to Kandahar, and I was informed that a route survey was required from Chaman.

This was commenced on the ¼-inch scale with prismatic compass and perambulator on the 26th February. On that day I met Captain Heaviside at Gatai, and from him I obtained Captain Rogers' values of two points on the Khwája Amrán range, viz. Khojak and Khwája. With the assistance of these two points, and my traverse plotted back to Chaman, I was enabled to continue my route survey from Gatai to Kandahar with the plane-table and perambulator.

Owing to the length of the marches, which averaged over 15½ miles, and the severity of the weather, little geographical knowledge was obtained beyond a few miles on either side of the actual route.

Kandahar was reached on the 4th March and the route survey completed. From results which have been since obtained, the perambulator traverse of about 78 miles proved most successful, the error being almost nil on the scale adopted.

We returned from the Khakrez reconnaissance on the 3rd of May, and the computations for the Kandahar survey were resumed; and when completed, I was employed in projecting all the plane-tables and teaching. The Assistant Quartermaster-General having expressed a wish that the detail survey of this plan should be carried on as much as possible by the Assistant Field Engineers attached to the force, the plane-tables were projected accordingly, and the work duly apportioned.

I took up the hilly portion of the work with Captain Sartorius, whilst three sub-surveyors commenced the open ground, and Lieutenant Baynes, 60th Rifles, and Lieutenant Small, 59th Regiment, Assistant Field Engineers, were allotted small portions in the immediate neighbourhood of the town. The detail work was commenced about the 1st June; but a sharp attack of fever compelled me to return to Kandahar on the 5th, and Captain Beavan took up my portion of the work.

When sufficiently recovered, I took up the mapping of the Khakrez district and various computations, as the medical authorities would not allow me to take up field work again.

On the 16th August I left Kandahar with Lieutenant Small with instructions to get in what we could north and east of the Barghána route.

Here again I regret to say my health failed, and after being laid up at a village for some days with fever, I was compelled to make the best of my way to the Khojak range, which I reached on the 30th August.

On the 8th September, feeling somewhat recruited in health, I commenced a survey of the Khojak pass on a scale of 6 inches to a mile, but fever and dysentery again disabled me, and on the recommendation of my medical advisers I was induced to apply for a medical certificate.

Orders were received from head-quarters, Kandahar, for me to proceed to Quetta to appear before the Standing Medical Committee, and I accordingly left Chaman on the 29th September, arriving at Quetta on the 4th October. Before leaving Chaman I managed to complete the Khojak pass survey from Chaman to the military post east of the crest of the pass, and also marked out some ranges for the guns in the Chaman Fort.

Extract from report by CAPTAIN CHARLES STRAHAN, R.E., *Deputy Superintendent, Survey of India, attached to the Peshawur Column of the Afghanistan Field Force.*

THE following officers were at different times employed on the work, viz. Colonel Tanner, Captain Samuells, Major Leach, Mr. G. B. Scott, and myself. Of these, Captain Samuells died soon after the commencement of the campaign, and Major Leach was obliged to return to India in consequence of a wound received in March. Colonel Tanner and Mr. Scott only worked throughout the whole time without interruption. I myself joined at Jelalabad on April 2nd, having hurried up to take Major Leach's place. Until my arrival Lieutenant Hart, R.E., was placed under Colonel Tanner's orders, but he had very little opportunity of doing anything, as after the attack on Major Leach's party by the Shinwaris survey work was stopped until the last advance from Jelalabad was made. A small gap near Hada was filled in by him. Private Sullivan of the 10th Hussars was allowed, when not required on regimental duty, to assist in computing, recording, and in other office duties, and for three or four months rendered us considerable assistance. Sub-Surveyor Ahmed Ali was attached to the party during, I believe, the whole campaign, and made himself useful by making traces from the field sheets, keeping accounts, &c., &c.

The officers and others at different times employed on survey work.

Mr. Scott was at first occupied in surveying the country north of the Khyber Pass up to the Kabul river, through which run two alternative routes to Jelalabad. Nearly all this he completed on the scale of 2″ = 1 mile, a gap being unavoidably left to the north, where the river makes a sweep northwards. He was surveying here when he was attacked by a considerable number of Momands, and with difficulty made good his retreat to Fort Michni, with a loss of one corporal and one sepoy killed and one wounded; Mr. Scott himself had a very narrow escape. The fight lasted the whole

Survey of the country between Jumrood and Dakha up to the Kabul river to the north, and to the Bazar valley to the south, by Mr. Scott.

afternoon, and there is no doubt the safety of the whole party was due to his gallant behaviour, a full account of which, I believe, has already been sent you. Mr. Scott also reconnoitred to the south of the Khyber, besides compiling sketch maps beyond the Bazar valley, based on the hill ranges fixed by the Great Trigonometrical Survey, and filled in from native information. All his work is done on the plane-table, the necessary points having been fixed by him with a 7-inch theodolite from bases derived from stations of the Trans-Indus Survey. These maps include the route from Jumrood to Dakha.

Survey of country from Dakha to Jelalabad and Gundamuk, on which all members of the party were more or less employed.

It having been found impossible to carry on a continuous chain of triangles, Colonel Tanner measured a base line at Dakha, and by taking observations for azimuth and latitude he was enabled to recognise the mountain peaks already fixed by the Great Trigonometrical Survey. These being known, it became a simple matter to fix the position by observations to three or more of these known points. Intersected points were observed to from these stations of observation, and thus a sufficient number of reliable points were obtained to enable plane-tabling to be carried on for considerable distances on each side of the route; thus doing away with the necessity of a traverse, always a tedious and not very accurate method, and moreover preventing any accumulation of error. Stations at distances varying from 5 to 20 miles apart have thus been fixed independently, and, judging by the results of the final computations, I should think that there is not likely to be an error of 100 feet in the position of any one of them. At Jelalabad a second base line was measured, from which several new points were recognised; but in the final results these base lines are not made use of, and do not appear at all. It was found easier in the field to reduce the positions of the Great Trigonometrical points to rectangular co-ordinates, and to compute all others from them on that system, and not to use latitude and longitude. The origin selected was the centre of the degree between 34 and 35 north latitude and 70 to 71 east longitude. Considering the instruments used (the largest was a 7-inch theodolite), and the unavoidably unsymmetrical triangles by which many of the points are fixed, the results may fairly be said to be good.

Ahinposh station, close to Jelalabad, on which a great deal depends, is fixed from four stations of the Great Trigonometrical Survey on all sides of it; the greatest difference in a common side of 30·8 miles was 64 feet. The heights are, whenever possible, deduced from trigonometrical observations; others are from aneroid observations.

Area and limits of country reconnoitred.

The total area mapped is about 2,200 square miles, but besides this a considerable amount of geographical information has been obtained to the north and north-west of Jelalabad, up the Kunar river and into the Lugman country. To the south, wherever possible, sketching has been carried on up to the watershed of the Sufed Koh, but there are two or three places where large blanks have been unavoidably left in the northern slopes of that range. Up to the foot of these hills the whole country has been mapped with more or less accuracy. The northern limit of the survey may be taken as the Kabul river from Fort Michni to Jelalabad, and from that place to the Surkhpul the watershed of the Siah Koh forms the boundary. The extreme western limit is the Surkhab river from Hisarak to Surkhpul. The ground in the neighbourhood of Tutu, Hisarak, and Ishpan was never thoroughly reconnoitred, except along the route itself; but there is not much detail in it. The course of the river and the positions of the above-mentioned villages are nearly correct. Beyond the river nothing was done in the way of mapping, but mountain tops in the Karkacha range were fixed by triangulation. At all times every opportunity was taken of fixing the position of distant snow peaks.

Join Colonel Tanner at Jelalabad.

On the 19th March, whilst on privilege leave, I received your telegram ordering me to proceed without delay to Jelalabad to take Major Leach's place.

I reached Peshawur on the 24th, and spent three days there in completing my equipment, marching to Jumrood on the 27th. On the 2nd April I arrived at Jelalabad, having met Major Leach at Basawal on my way up. I found Colonel Tanner had started two or three days previously on an expedition, with a force under Brigadier-General Macpherson, into Lugman, from which he had not yet returned. During the afternoon the sound of guns was plainly heard from the direction of Fattehabad, where Brigadier-General Gough was encamped. The next day we heard of his engagement with the Kogianis, when Major Battye of the Guides, and Lieutenant Wiseman, were killed.

On the 3rd April General Macpherson's column returned, having hurried back to Jelalabad on hearing the firing at Futtehabad. Their object had been to catch Asmatullah Khán, a Gilzai chief, who was reported to be at Bahram Khan ka Killa stirring up the tribes in Lugman against us. The information was correct, but the Khán received intelligence of the approach of our troops, and escaped very shortly before their arrival. As most of the marching had been done during the night, Colonel Tanner had but little opportunity of adding much to his map. It was now agreed upon that all superfluous instruments, baggage, and everything not really necessary, should be collected and placed in a storehouse, which the Engineers promised to build for us in the fort at Jelalabad, then under construction. This I undertook to see done, whilst Colonel Tanner joined Mr. Scott, who was with General Gough at Fattehabad.

In a little more than a week the storeroom was ready, and I had everything housed. Leaving two men in charge, I marched towards Fattehabad with the head-quarters and General Macpherson's brigade. On the way I extended Colonel Tanner's sketch map of the road one and a half mile to the south. At Sufed Sang we all three met, and as soon as possible commenced a survey of the country around. This camp was also called Gundamuk. The

village of that name was two miles beyond our camping ground, and the old cantonments of Gundamuk, the mud walls of which still remained to show the site, were at the same distance, a little to the south of the Kabul road. The name Sufed Sang signifies "white stone," and applies to a remarkable rock in the bed of the river Murkhikhel, which flowed close by the western side of our camp. Some people say that the rock was blown up by our Engineers when making the road down the river bank, but I believe the real stone is in the bed itself. This river was formerly bridged, and on our arrival the central pier and the approaches on each side were still standing. These were utilised for the trestle bridge built by us, and which became very useful when the waters began to rise from the melting of the snow in the Sufed Koh, whence the river has its source. Until the bridge was built a causeway of loose stones was thrown across, over and through which the water made its way. At no time, however, was there enough water to have rendered the passage of the river very difficult.

The route from Jelalabad to Sufed Sang.

From Jelalabad the first ten miles lay through a flat country, with numerous villages and a great deal of cultivation to the north, up to the foot of the Siah Koh. On the south were low stony hills, amongst which I reconnoitred on the march. They were uninteresting and barren to a degree, and beyond one small village (principally consisting, as far as I could see, of caves in the hill-side) and one small fort I saw no signs of inhabitants for several miles. The road was very heavy, a great deal of it being over a large river-bed, which, except at one part, was quite dry. In this sandy place the drainage from the low hills to the south seemed to lose itself, and it was not easy, when making a hurried sketch, to lay hold of anything definite. Between the route and the Siah Koh flowed the Surkhab river, and near this river, at a distance of 10½ miles from Jelalabad, a post was placed in a new Afghan fort built by some Khan, but never occupied by him. We christened this fort Rosabad, but I believe its real name was Arsala Khan ka Killa; but of this I am not quite sure. The buildings never having been occupied by Afghans were clean, and the quarters there became in the hot weather the most comfortable on the whole line. The water-supply was from irrigation channels, one of which passed through the fort itself, but could of course at any moment be turned from outside. The inhabitants of the surrounding villages were luckily very quiet and friendly, and the officer commanding had but little difficulty in persuading them to let it flow during certain hours of the day. The principal use of this stream of water was to turn a turbine, by which a punkah, formed of grass mats on a vertical axis, was worked round and round. This was a great boon to those who had the chance of sitting near it, not only on account of the draft it caused, but also because to a great extent it kept off the flies, which at one time became a perfect plague, more particularly at Jelalabad.

Rosabad, 10½ miles from Jelalabad.

From Rosabad to Fattehabad was 4½ miles; a gradual ascent the whole way; country open on both sides. The village itself looked refreshingly green after the dreary dusty camp at Jelalabad; to the south and south-east were some low stony hills, of which Colonel Tanner took advantage for the triangulation. About 1¼ miles west of the village a small river was crossed. The bed was, as usual, stony; and on our return journey, when the snow was melting, the water was nearly knee-deep and running strongly, but it was not deep enough to cause any difficulty in fording it. The bed of the stream was only a few feet below the general level of the country. From this stream the road led across a wide stony plain almost devoid of vegetation. It was on this that the action of the 2nd April took place. On passing this plateau the road descended into a narrow valley, and wound amongst low hills and broken ground until it entered the Nimla valley. On the edge of the plateau, just above the descent, was another of our posts, called Fort Battye, Major Battye having been killed close by the spot. The village of Nimla is situated in a deep narrow valley watered by a small stream, which does not take its rise from the snowy mountains, but still, I believe, never dries up. The only object of interest at Nimla is the garden, which is thickly planted with magnificent trees of several different kinds.

Fattehabad 4½ miles from Jelalabad.

Fort Battye, 18 miles from Jelalabad.

Nimla, 22¾ miles from Jelalabad.

The line the road eventually took avoided the village itself, crossing the valley about a mile to the north of it, and ascending the opposite hill ran along the top of the western side of the valley. Two other country roads led from the village on to the heights above. Here was another stony plateau, apparently extending unbroken for some miles, but in reality intersected by numerous deep nullahs or narrow valleys running nearly parallel to each other from south-west to north-east. These were invisible until you reached their very edge. Our camp at Sufed Sang was on the southern extremity of this plateau; on some low hills again to the south was a long slope of cultivated country reaching to the very foot of the Sufed Koh. From Nimla to Sufed Sang was only three miles. Here we made a long halt, in fact until the troops returned to India, for beyond this we never went, except for purposes of reconnaissance. At first it was thought advisable not to go far from camp, but after allowing a short time for the country to settle down after the fight near Fattehabad, we were permitted to go out surveying with a small escort of sepoys as far as we liked, so long as we returned to camp before sunset, and did not enter the Gilzai country, which lay beyond that of the Rogianis, in which we were encamped. It was then arranged that I should undertake the survey to the north of the route, whilst Mr. Scott worked to the south, and Colonel Tanner looked after the triangulation.

Sufed Sang, 26 miles from Jelalabad.

Surkhpul, 35½ miles from Jelalabad.

One of my expeditions took me to the Surkhpul, where the Kabul road crosses the Surkhab road by a masonry bridge of one arch. It was in very fair order, a portion of a retaining wall only having partially fallen down. The water came rushing through a narrow gorge, at the mouth of which the bridge was built. It was said to be fordable either on foot or on horseback, but at that particular place looked anything but easy. Whilst at work, my guide pointed out the hill on which the remnants of the Kabul force in January 1842 made their last stand. Being obliged to push on rapidly, I was unable to ascend it at the time, but others who visited it a few days later found a considerable number of human bones. That these were really the remains of our unfortunate soldiers may possibly be open to question, as it seems extraordinary that bones should still be in existence after a lapse of 36 years, exposed to frost and snow in winter and a scorching sun in summer. Still it is difficult in any other way to account for their presence there, as the Afghans bury there own dead, and there did not appear to have been any subsequent fight on the same spot. On the supposition that they were the remains of our men, a working party was sent out to collect them and to build a large cairn of stones over them. The hill is hogbacked, parallel to, and immediately over, the road which runs to the south of it. From the west the ascent is gradual and easy, to the north and south the sides fall steeply, and to the east the slope is considerable and somewhat steep, into a valley which the road enters. The whole way from Jagdallak, some 20 or 25 miles I believe, they had been carrying on a running fight against overwhelming numbers, at first of Gilzais, and then, after crossing the Surkhpul, of Kogianis, who joined in, fresh for the fray. Hundreds had fallen on the road, and the small body still left, under the command of Major Griffiths, no doubt seeing that if they entered the valley they would be at the mercy of their enemies, took up a position on this hill, which gave them a considerable advantage, and there they made a last gallant stand. As their ammunition was failing them, they attempted to make terms; but whilst Major Griffiths was conversing with the Khan of Tutu, and there seemed some slight hope that the Afghans would listen to reason, a final onslaught was made, a last volley was fired, and then they were almost all cut to pieces. Major Griffiths and Captain Souter escaped, and were taken as prisoners to Tutu. Some three weeks later, when I was observing at a station close to that place, Akram Khan, who was escorting me for the day, told me that Captain Souter had been kept a prisoner in the house of his father, Shamshadin Khan; that he himself was a boy at the time, but that he could recollect "Souter Sahib," and how he had taught him a few English words. The only one which he could still remember was "smoke," which, however, I could not understand until he explained its meaning through my interpreter. He also showed me a letter, asking me whether it was of any value. This letter was written partly in ink and partly in pencil on native paper and folded up without an envelope, and addressed to Captain Fenwick, 13th Regiment, Jelalabad. Judging by the excellent preservation in which it was, it must have been very carefully kept. The following were the contents written in ink, and might have been written a few weeks ago instead of 36 year:—

"My dear Fenwick,

"To my sorrow, the kind hopes entertained in your letter that I "should soon be released have not been realized, my detainer having increased his demand for "my ransom. I have written a long letter to Captain MacGregor by my detainer, who takes "it to Brigamer Fort (*illegible*). Pray go to MacGregor, read my letter to him, and try what "can be done to obtain my release. My family must have heard that my regiment are "destroyed, and are naturally in great distress about me.

"I have recovered the regimental colour of my regiment, which I had about me when "I was cut down and taken prisoner; the other colour was in the possession of a sergeant "who was killed upon the road during the night. There are two men belonging to the "regiment in this neighbourhood recovered from their wounds; an artilleryman died three "weeks ago.

Yours sincerely,

T. A. Souter."

On the back was written in pencil:—

"I write this as I believe it to be Sunday, the 30th January 1842. The Mullick, though "he promises to start to-morrow, I apprehend it will be the following day before he does do "so. I have neither seen nor have been able to hold any intercourse with Major Griffiths "since the first day I arrived, now nearly three weeks—a long time to wear a bloody shirt."

The Khan explained to me that he had picked up the letter by the side of the Jellalabad road, and had kept it. This appeals to be a most unlikely way for it to have come into his possession; it is much more probable that his father delayed delivering it, and that in the meanwhile Akbar Khan carried Captain Souter and the other prisoners off into Lugman. The letter would then have become useless, and was probably kept as a curiosity. Having read this interesting relic, I made a copy of it in the flyleaf of my angle book. I explained to the Khan that it was only a private letter from Captain Souter to Captain Fenwick, and that it was of no real value to any one. I don't think he quite believed this, and as he wished to have it back again, I returned it, so as not to make him think too highly of it, intending to get it out of him some future time. Unfortunately our sudden return to India about a fortnight afterwards prevented my ever seeing the Khan again, and thus I lost the chance. Sir F. Souter of Bombay, who had seen an account of my finding his father's letter in one

of the papers, telegraphed asking me to procure it for him; but I was then just on the point of marching away from Gundamuk. I sent his telegram to the late Sir L. Cavagnari, but I never heard whether the original was obtained or not.

From Sufed Sang to Surkhpul, 9½ miles.

As I have already mentioned, no advance was ever made beyond Sufed Sang, but the country was reconnoitred as far as the Surkhpul, and the improvement of the road commenced. One and a half mile beyond the Murkhikhel river the road crossed the Noyan river at its junction with a branch from the lower hills, and which was consequently unaffected by the melting of the snows. As the hot weather commenced, the one increased as the other diminished. The bed of the two streams together was of considerable width, a small tongue of land over which the road passed separating the two. The ascent on the far side was rather bad, but did not require very much to render it passable for artillery. About three-fourths of a mile from this stream the remains of the old cantonment of Gundamuk might be seen half a mile to the south of the road. The village of that name was to the north of the road, near the banks of the stream. Not half of it could be seen from the road, as it was situated on low ground. For 1¼ miles from the Noyan the country was flat and open with a good deal of cultivation, and then came a sudden descent into rather a deep valley, along which the road wound for 1¼ miles, when it again ascended by a very rocky narrow path, which would have required a good deal of blasting to make it practicable for artillery. At the top of this ascent was the "red hill," already described as the scene of the last massacre of the Kabul army of 1842. It is a curious fact that the soil close to the road at this spot and on part of the hill itself is of a markedly red colour, so much so as to quite catch the eye from a considerable distance. I saw none of it elsewhere, and it seemed as though nature had set her mark on the place. This rough ascent being passed, the road ran along an open valley with low hills to the south, those to the north being some little distance from the road, much higher, and forming one continuous range. Another small stream was met with, which presented no great obstacle, and then came the Surkhab river, crossed, as I have said, by a masonry bridge of one arch, spanning the mouth of a rocky gorge. Beyond this I did not go, but I could trace the road for three or four miles further on steadily ascending from the river up an open valley, with low hills on each side of it, exactly similar to that by which the river had been approached.

Expedition with Colonel Tanner into the Sufed Koh mountains.

By the beginning of May the country seemed quiet all round us, and Colonel Tanner and myself obtained permission to make a trip into the Sufed Koh and sleep out for two or three nights, or even more, if we met with no difficulties. Haidar Khan, of Gundamuk, with 20 followers, formed our escort; none of our own sepoys accompanied us. The difficulty of feeding them would have been great, and the few that we could have taken with us would have been of but little use had any serious attack been made on us when cut off from all help from the main camp. It was better to trust entirely in the influential Khans, who had already shown that they were trustworthy whilst accompanying our small parties during the previous day's expeditions. I do not mean to suggest that the Kogianis were any more to be trusted than other Afghan tribes, but they had quite recently had a severe lesson from our troops, and they were quite well aware that their principal villages were entirely at our mercy at any moment, and would assuredly be destroyed if they behaved treacherously. Our plan was to ascend a spur, which, with our glasses, we could see led directly to the summit of Sikarram (not Sikaram as it has been hitherto called), the highest point of the whole range, 15,620 feet above the sea, and there to select some halting place from which we might explore and, if possible, eventually ascend Sikarram itself. We had but little chance of this we were assured so early in the season; but as Colonel Tanner was shortly intending to make a start for Kafiristan, and was anxious to see what he could of the Sufed Koh before he left the country, we were obliged to go at once. Our equipment consisted of a theodolite, plane-table, aneroid barometers, and a hygrometer, a bundle of bedding and some provisions, and as few kitchen things as possible. Everything, including the bedding, &c., of the four or five khalassies who came with us to carry our instruments, was packed on two mules. In this light marching order we started early on the morning of the 6th May. On leaving camp we made straight for the village of Murkhikhel, through the cultivated country I have spoken of as lying to the south of our camp. This country in reality sloped very rapidly from the foot of the mountains to the Surkhab river, which received all the drainage of the valley, but in consequence of the high hills beyond it was difficult to realize how great the gradient was. The difference in level between the camp and Murkhikhel village was 1,500 feet or more, and the distance only five or six miles. The soil appeared by nature to be of the same stony, barren kind as that north of the camp, but being thoroughly irrigated by means of small canals from the river it yielded excellent crops; the green trees round all the villages also proved that it was only want of water which rendered the country on the whole so bare. Every village had its groves of mulberry-trees and huge old vines growing in beautiful masses over the trees; round the larger villages other fruit-trees, such as peach and pear, were to be seen; but we left the country too soon to taste any of the fruit, except that of the mulberry, which was white or only slightly purples, and very sweet, but greatly wanting in flavour compared to the English mulberry. About a mile short of the village of Murkhikhel we turned to the right and, descending a narrow path down to the river, crossed over to the other side Here we soon left the irrigated land, and again found ourselves crossing a sort of stony desert much intersected by deep *nullahs*. As these only took their rise from the lower spurs of the mountains, they were all dry. Our path

led us gradually to the foot of the hills, which we reached at about 10 o'clock. As the ascent was steep for laden animals, we got off our ponies and distributed our baggage amongst the four animals. The path was much used by woodcutters, and was by no means a bad one, and might with very little labour have been made much better. Our aneroids made this point 6,200 feet above the sea and 1,700 feet above the camp. The top of the spur we made upwards of 8,500 feet. At 7,000 feet we noticed the first pine, the hill-sides so far having been singularly free from vegetation. About mid-day we found ourselves on a picturesque little undulating plateau, pretty thickly covered with pine-trees, through which wound a small brook. Here we were shown the remains of some Kafir fort or building, but could find little more than the foundations of a rectangular building 168 feet by 66 feet, divided into two unequally sized rooms of 93 feet and 75 feet in length respectively. More to the east on the same hill we were subsequently shown some other remains, but could make little or nothing out of them. Our guides could give us no information on the subject beyond the fact that they were supposed to be Kafir remains; the place was called Taraki. I attempted to get a plane-table fixing here, but since leaving camp in the morning heavy clouds had begun to gather, and were now hiding all the snow peaks, and I could do little or nothing. Very soon after the rain began to fall, but, fortunately for our comfort, not very heavily nor for very long. Our path followed the little stream I have already mentioned along a very picturesque valley, and finally emerged on the opposite side of the hill, upwards of 2,500 feet above the Murkhikhel river. One small village only was to be seen on the opposite side of this large valley. Only a fortnight before we had noticed from camp that the hills we were on had been covered with snow, but these were now quite clear. On the opposite range, however, which was much higher, there were still some 3,000 feet covered with snow, and looking up the valley to the higher summits of the range it was all snow; many of the extreme points reach the limits of perpetual snow. We encamped for the night at Khadar Khan ka Burj, also known as Sera Tiggi, where was a two-storied mud tower, which we occupied, whilst our men and the Kogiani escort slept in some rude huts alongside. Our height here was 8,000 feet or rather more.

The next morning we started early with only our instruments and food for the day, leaving our baggage at the tower, the weather being too unpromising to allow of our doing more than exploring during the day and returning at night to where we had shelter.

Before mid-day we had attained an altitude of 10,500 feet, having left the pines almost entirely behind, and had got well into the snow. The summits ahead of us were all hidden by clouds, but still we could trace our spur for a considerable distance further, and as far as we could see there appeared to be no difficulty ahead of us.

There were, however, some ominously black clouds sweeping over the mountains to the east, and we thought it advisable to see what they portended before we went much further; so we selected a sheltered spot and had some breakfast. The only vegetation visible above the snow at this height were shrubs in general appearance greatly resembling the "arbor vitæ." On the way up we had remarked four different kinds of pine, including the deodar and the edible pine. There was a singular absence of ferns or of undergrowth generally, partly due, no doubt, to the time of year; but even lower down, where spring was well advanced, we had seen no ferns. Aromatic herbs of several different kinds seemed to be very common. One growing in quantities near our camp at the tower gave out a very strong odour of peppermint as we crushed it under foot. At Taraki we had picked up pieces of white or pinkish soapstone, and had afterwards found masses of it all over that part of the hill. Not long after breakfast snow began to fall, and it was evident that we should see nothing more, even if we pushed on. As it was, I had been unable even to fix our position on the plane-table, all the points being obscured by clouds. To the north, where we ought to have had an extensive view of the snowy ranges of Kafiristan and the Hindu Kush, we could hardly make out the Siah Koh, not more than 20 miles from us. There was nothing to be gained by persevering under such adverse circumstances, so we commenced our retreat. The whole of the way back it continued more or less to rain, for we soon left the snow behind, and we were pretty well wet through by the time we reached our tower. During the night it rained very hard, and notwithstanding our having an upper story above us the water came pouring in. Luckily the sides of the room, the floor of which was of mud, were higher than the centre, so after a little manœuvring we found dry places near the walls. By the morning the centre of our apartment was a pool some 3 inches deep. At daybreak, although not absolutely raining, it looked almost as bad as before, and we decided on returning to Sufed Sang. Before we got clear of the hills it rained again, but on reaching the camp we found that although heavy clouds had been hanging about they had had nothing more than slight showers. From a surveyor's point of view, our expedition had been almost a complete failure; but we had seen enough to show us that we were probably on the right line for ascending Sikarram, and should probably have succeeded had we had fine weather. We had also proved the feasibility of making long expeditions in the Kogiani country, when escorted by one of the leading Khans of that tribe. During our absence the Amir Yakub Khan had come into camp; his arrival was likely to still further facilitate our survey operations, more particularly as Asmatullah Khan had also come in to pay his respects to Sir L. Cavagnari.

Arrival of Yakub Khan at Sufed Sang.

The day after our return, viz. May 9th, Colonel Tanner left for Jelalabad preparatory to starting on an expedition in Kafiristan, leaving Mr. Scott and myself to carry on the work. The results of the triangulation since leaving Jelalabad not having been very satisfactory, I deter-

Colonel Tanner leaves for Jelalabad *en route* to Kafiristan.

Triangulating.

mined to re-observe at the four stations in the neighbourhood, and to take more astronomical observations to determine our azimuth, the accuracy of which I doubted. These, and the computation of the points resulting from them, fully occupied me for nearly a fortnight, the results having been greatly improved. I now had reliable points fixed all round for a distance of some 20 miles ahead, up to the crest of the Karkacha mountains, beyond which we could not see. These, although very far short of Kabul, would be of considerable assistance in carrying on our survey by plane-tabling, and would give us starting points again on which to base the work beyond, if we had the opportunity of advancing towards Kabul. I asked leave to make an expedition into the Siah Koh, and was told that I must lose no time, and must also arrange to keep up my communications with the head-quarters camp, as orders for our immediate return were daily expected. Knowing something about signalling, I took a heliograph with me, and said I would each day manage to signal to camp, so that they might have an opportunity of recalling me if necessary. Seeing that our survey days were numbered, I instructed Mr. Scott to start at once for Tutu, and to explore the Sufed Koh in that direction, filling in up to the Surkhab river and reconnoitring its eastern sources, whilst I visited the Siah Koh. Mr. Scott was unable to survey between Tutu, Hisarak, and Ishpán, but he succeeded in ascending Sikarram, and sketched in a good deal of the mountain range, besides obtaining trigonometrical observations to distant peaks.

Reconnaissance amongst the Siah Koh.

On Sunday, the 25th May, escorted by the Khan of Tezin, a Naib of Asmatullah's, and 20 Gilzais, I left Sufed Sang and made for the village of Liasi Khel on the Surkhab river. Hitherto I had not been allowed to descend into this valley, all the villages belonging to Gilzais, and so I took this opportunity of correcting my sketch of the river as I went along. We passed Liasi Khel, and following the right bank of the river we reached Durani Kach, near which village we forded the river. This large stream has its main sources in the Sufed Koh, and receives all the melted snow from the northern slopes of that range. It is consequently in flood during the whole of the hot weather, and in some seasons must be, I should think, almost unfordable. There having been comparatively little snow during the preceding winter, it was not as high as usual, and we managed to cross it without much difficulty, the Gilzais, fine, powerful, heavy men, helping over my weaker khalassies, who were men from India. At Hisarak the main stream leaves the Sufed Koh, and flowing in a north-easterly direction receives the waters of the Aozangani and of the Karkacha, which take their rise from the Karkacha range. It then passes through some low hills near the village of Ishpan by a narrow rocky gorge, at the exit from which is the Surkhpul. It almost immediately enters another gorge 1,400 feet deep, on passing which it receives another stream from the direction of Jagdallak. From this point it flows along a narrow valley at the foot of the Siah Koh, past the villages of Durani Kach and Liasi Khel, after which the country to the south becomes more open. It continues to flow at the foot of the Siah Koh, receiving the Noyan and other streams from the south, but little or nothing from the north, till near Bálabágh, whence it flows through cultivated country till it joins the Kabul river, five miles west of Jellalabad. Its name, "Surkhab," signifies "red water," and it is very appropriate, for its waters are of a remarkably red muddy colour; so much red mud is held in suspension that the fields irrigated by canals from this river become of a similar colour from the mud deposited on them. This red soil is derived from the Sufed Koh and the Karkacha mountains, for I noticed that both the Surkhab itself and its two branches, the Aozangani and the Karkacha, are all of the same colour, whilst the Murkhikhel, the Noyan, and others, are all either clear or full of grey-coloured mud. Almost immediately after crossing the river we commenced the ascent, the latter part of which was decidedly steep, but our animals ascended it easily enough. Unlike the Sufed Koh, there were no pines; indeed the extreme summit is scarcely up to the line at which the pines commenced. Vegetation was poor and scanty, consisting of small stunted-looking trees or bushes, the prickly oak being very common; the wild olive was also pointed out to me. At the top we found a comparatively flat open plateau, with higher hills rising up again from it. This was known as Chappar, and scattered about it were small hamlets or camps of shepherds, but no large villages. This name of Chappar seemed often to be applied to the whole range, called by us the Siah Koh. At one of these we made arrangements for sleeping, a hut being set aside for my use; but it proved to be so filthy, and swarmed so with fleas, that I could not enter it, much less sleep in it. The flat roof of the hut was far preferable, so I made a little shelter tent with my waterproof sheet, and slept underneath it. I was very glad I had done so, for during the night the wind rose and blew hard for many hours, which would have been extremely uncomfortable without any shelter at all. The next day I spent in observing from a peak some two or three miles to the west, and in sketching the country round about. I had a magnificent view from this hill—snowy ranges on three sides of me. To the south the Sufed Koh stretched for miles, forming a great wall, which effectually closed the view in that direction; but to the west I could see the snows beyond Kabul, and could trace the valley in which the city is situated, but the capital itself was hidden by intervening hills. To the north-west, far away in the distance, I could just see the Hindu Kush, and to the north and north-east were the mountains of Panjsher, Kohistan, and Kafiristan; to the east was the Jellalabad valley, with the Tartara hills beyond it. Below me, to the north, was the open country of Lugman, through which flows the Kabul river along the base of the Siah Koh, whilst from the hills to the north come the Alishang and Alingar rivers, which join the united stream flowing into the Kabul river. To the south was the valley of the Surkhab, with our camp at Sufed Sang plainly visible. The courses of the Alishang and Alingar rivers were very clearly marked out by strips of cultivation and green trees on either side, which looked like a green riband on a dust-

coloured ground. There did not appear to me to be nearly so many villages on the Kabul river below me, but towards the east they seemed to increase considerably. The rest of the country was, as far as I could see, barren and stony, similar to that in the Kabul valley. If stones were a source of wealth, Afghanistan should be a rich country. I was of course too far off to do much sketching, but still I was enabled to get a rough idea of the courses of the rivers below, and of the general run of the mountains, thereby correcting the old maps, which are very wrong as a rule.

We passed the night at the same place, and had another disagreeable windy time of it.

The following day I spent in exactly a similar way on another peak to the east, picking up most of the points I had observed to on the previous day, but towards Kabul itself, nearer hills came in my way, and I lost some observations there that I had particularly wished to get. My camp had marched down the hills again to a small village near Tátang Waziri, so in the afternoon, after finishing work, I descended and re-crossed the Surkhab river. My camp was prepared under the shelter of a beautiful large palm-tree, much more comfortably than on the roof of a hut, exposed to a high wind on the top of the mountains. From here I had intended marching down the river to Kankrak, and thence to again ascend the hills to a prominent peak nearly over that village, from which I hoped to pick up many of my points again, and thus obtain a check value, besides lengthening the base on which they would depend. It was always our custom to say nothing the day before of our intended movements, as this greatly decreased the chance of any premeditated treachery. It was consequently not until the next morning that I discovered that the peak I wished to visit was not in Gilzai territory, and that my escort could not take me there. We were only six miles from Sufed Sang, so I marched back and tried to see Sir L. Cavagnari in order to arrange with him for a fresh escort.

I failed in obtaining an interview that day, and on the next, when I had everything prepared for a fresh start, I received orders from Colonel MacGregor to accompany Major Stewart to Alikhel over the Lakarai pass, of which more anon.

Passes over the Siah Koh.

Colonel Tanner had already reconnoitred two passes over the Siah Koh, one from Tátang, near Arsala Khan (which must not be confounded with Tátang Waziri on the Noyán river), when he accompanied General Macpherson to Bahram Khan, and the other known as the Wara Gali, which starts from Kankrak. With the exception of mountain paths, accessible only to men on foot, I do not think there is another pass until you get to Jagdallak, but from Tátang Waziri a road over the mountains, known as the Kirskháná route, leads to Jagdallak, avoiding Fatteh-abád, Nimla, Gundamuk, &c. A person travelling by this route from Jelalabad would follow the course of the Surkhab to Tátang Waziri through cultivation, the greater part of the way. From Kankrak to that place there is only a strip of flat country between the river and low hills, across which run several deep nullahs, which would be troublesome in making a good road. At Tátang the road crosses first the Noyán, and then the Surkhab. Both streams are very rapid, but not deep, running in several channels over round boulders. On the opposite bank is a small Gilzai village called Amin Khan ka Killa, and from this the ascent commences. As it stands, it is fairly good and is quite accessible for mules and ponies, and I should think for camels of the country. After crossing the plateau on the top called Chappar, it winds along the side of a valley some 300 feet above the small stream at the bottom, with rocky hills immediately above the road. The small village of Amluk is in this valley, but I did not get quite up to it, only seeing the site of it from one of the neighbouring hills. Beyond this I could not trace the road, but was informed that for 7 or 8 miles there was no water, and that it followed along the top of the range till it descended rather abruptly to Jagdallak. As a natural highway it cannot possibly be compared with the route either up the Surkhab valley or that up the Kabul *vid* the Adrak Badrak pass, as the ascent and descent of the Siah Koh is all extra labour; but still it is occasionally used, as being a quieter route, avoiding large villages. During our occupation of Gundamuk I know it was made use of, as I myself saw a small caravan of mules ascending from Amin Khán.

The Kirskháná route.

The Siah Koh (or Black Mountains, in contradistinction to the Sufed Koh or Snowy-white Mountains) are rocky, barren, and uninteresting; parts are covered with huge rocks, sometimes piled one on the top of the other, making walking very slow and tiresome, and in the hot weather very trying from the heat given out by the rocks. The drainage is mostly to the north, into the Kabul river, the slopes into the Surkhab being generally abrupt, and in some places quite precipitous. There are a few small villages on the top, but the permanent residents cannot be numerous. The second day after I got back from the Siah Koh orders were received for the immediate return of the troops to India. At the same time Colonel MacGregor ordered me to prepare for an expedition to Alikhel, in order to reconnoitre and report on the route from Gundamuk *vid* Hisárak, Mangah, and the Lakarai pass. Major Stewart, who was thoroughly conversant with the language, was to collect all possible information, whilst I was to make a reconnaissance of the road, supplemented by landscape sketches of any particularly difficult pass. The distance was supposed to be about 60 miles, the greater part of which was in Gilzai territory. As our relations with that tribe were of a somewhat uncertain nature, it was thought advisable to hurry through as fast as possible, spending only one night on the road. On the 31st May we left Sufed Sang with two lightly laden mules, escorted by Asmatullah's Naib, who had already once accompanied me, and 18 Gilzais. I also had a Pathán khalassie, who acted as my interpreter, and Major Stewart took with him a man from his regiment (the Guides), whilst

a third man came to look after the mules. We had not got far on our journey when the Naib told us that he could not undertake to escort us by Hisárak along the proper road, as Mahomed Shah Khan of that place would assuredly stop us, but that if we wished it he would take us by a path through the mountains, which was a more direct route, but a more difficult one, and which avoided Mahomed Shah Khan's villages altogether. Once past his country he said he should be all right, as beyond, up to the Lakarai pass, was all Asmatullah's territory. This was bad news, but there seemed to be no choice between going back altogether or following the Naib's advice and taking the short cut. Had our object been merely to get to Alikhel, it would have been of no consequence; but our orders were to report on the whole road, and this we should now lose all chance of doing unless we could manage to come back that way. We neither of us approved of turning back, so we decided on taking the short cut and telegraphing from Alikhel for arrangements to be made for our return *viâ* Hisarák. Our route led us past Tutu and Petla, both of which villages we left to the south, to Nalgozi, a small Gilzai village, the other two being Kogiani. Here we stopped for a few minutes and ate a very hasty breakfast, hurrying on, as the demeanour of some men from the village who came to have a look at the "Feringhees" was anything but friendly. When he had got us out of the place, the Naib, contrary to our wishes, stayed behind himself, and kept us waiting at the foot of the hills for upwards of half an hour. There had already been a little delay in getting away from camp, and this second delay was most annoying, and, as it turned out afterwards, was most disastrous to the success of our expedition, for we heard that it was at this time that news of our arrival was taken to Mahomed Shah Khan, who, at once despatching men after us, succeeded in catching us before we had got clear of his territory. On the Naib's rejoining us with the remainder of our escort, we lost no time in ascending the hills. A climb of about 2,000 feet landed us at the top of the spur, on which, there being a good view, I begged to be allowed to put up my plane-table.

Up to this we had been the ones anxious to get on, and had been doing our best to hurry on our Afghan friends, who are most inveterate dawdlers; now they were all for pushing ahead, and would only allow a very few minutes' halt. I got a fixing, but had no time to do a tenth part of what I should have liked to have done when I had to pack up again. Our path then led us round the head of a narrow precipitous valley, past a single hut and a tent, pitched on a spur overlooking the valley, and only accessible by a narrow path from the hut. On enquiry we were told that some of Mahomed Shah Khan's family were living there, and we were told not to stop, but to pass on as quickly as possible. One of our escort spoke to some armed men, apparently acting as a guard to the tent, and but little or no notice was taken of us so far as we could see. From this the road led over a small cultivated plateau, on the other side of which it commenced a gradual descent into a deep valley by a narrow path cut out of the rocky side of the hill. Here again we saw a small camp in the valley below us, said to be some of the Khan's people. Still no attempt was made to stop us, and we thought but little of these two small camps. On reaching the stream at the bottom of the valley the Gilzais stopped to say their prayers, but we went steadily onwards, one man accompanying us.

The valley gradually became narrower, and the sides more precipitous, whilst the path, following the stream and constantly crossing from one side to the other, became more and more difficult for animals. As we were passing almost the narrowest part we heard some shouting behind us, and on looking back saw our escort, who had followed us, taking up positions amongst the rocks on each side of the path, preparing apparently to dispute the passage of several armed men whom we could see hurrying up from behind. We left them to settle it amongst themselves, and made the best speed we could, as if we could only pass over the head of this valley into the next we should be out of the Hisárak country. But now the path was worse than ever, and even on foot we could not make any great progress, whilst our animals and baggage, to which we naturally clung, delayed us still more. For another half hour we hurried on, and had great hopes that we should get through all right, as all seemed quiet behind us, and we heard no sounds of fighting. These hopes were, however, very soon dispelled, for presently two half-naked and unarmed men ran past us, gesticulating violently. These did not appear very formidable enemies, and we took no notice of them, when presently a large stone fell between Major Stewart and myself, quickly followed by another. On looking up we saw these two men perched on the rocks above us, and behind us was an armed man who had stopped our servants with the mules, and was trying to wrench the sword out of the hands of Major Stewart's sepoy, whilst numbers of others were running up. In a wonderfully short time we were completely surrounded by some eighty armed men, whose gestures, for I could not understand a word they said, were most insulting and threatening. Major Stewart and the Naib did their best to pacify them and to get them to listen to reason, but to very little purpose. On several occasions they seemed determined to commence an attack, when nothing could have saved us. Our escort was, I believe, still with us, but it was almost impossible to tell friends from foes; and even supposing them to have been prepared to fight for us, which I think was very doubtful, they were completely outnumbered and surrounded. On every rock commanding the spot where we were standing were to be seen groups of two or three men with their long *jezzails* ready, and apparently only deterred from firing by the fact that some of their own men were mixed up with us in a group; and when one, who appeared to be something of a leader, drew his long knife and called to his men to separate themselves from us, it seemed as though all hope had gone. It was evident that their great object was to stop us, and not to take our lives, but still I cannot help thinking that we were in considerable danger, as there was no influential man to restrain the passions of these fanatical Mahomedans in whose power

we were. However "all's well that ends well," and by sunset an agreement was come to that we should sleep where we were, sending a letter to the Khan at Hisárak to know what he wished done. The excitement cooled down, but they took very good care that there should be no attempt at escape on our part. Immediately around us all were enemies, and on the rocks above could be seen groups of them watching: our escort formed another group some 150 or 200 yards from us. We had some cold provisions with us, and unpacking our bedding we made ourselves as comfortable as possible. At about 10 o'clock, after Major Stewart had had a long talk with the men, all seemed quiet, and we went to sleep. Not for very long, however, for in another two hours we were awakened by a good deal of shouting, and were informed that some of Asmatullah's men had joined, having been called to the rescue by one of our escort, who had managed to make his way to his friends' villages. These men joined ours, and they all danced a war dance, shouting and flourishing their huge knives in concert. What with the wildness of the spot, dimly seen by firelight, the flashing of the knives, and the fierce shouts of the men, it formed altogether the most striking spectacle I had ever witnessed. Again, not long after, there were fresh arrivals, but this time from the other side. And now our enemies again greatly outnumbered our friends, but how many there might have been on either side it was impossible to say. With these reinforcements from Hisárak came Mahomed Khan, a relation of Mahomed Shah Khan, and he at once took command. He told Major Stewart that we must pack up and prepare to start directly, and not even wait for daylight, which we eventually had to do, notwithstanding Major Stewart's representations of how much easier it would be for us to go back when day broke, the path not being a particularly good one for ponies even by daylight. Having tied up our bundles, they told us to leave them behind, to be put on the mules, assuring us that they would come to no harm. Thus we started to go back about an hour before daylight.

When day broke and we could see a little, we found to our great relief that our mules and ponies were really following us, and we began to hope for the best. On arriving at the tent which we had passed the day before we halted for a short time, and the Khan sent for his hookah, and, passing it round, we had an amicable chat. He assured us there was nothing to be feared now, and that although he was not himself going any further, another influential man would escort us to Hisárak. On recovering our ponies we each discovered that our holsters had been rifled, and my khalassie told me that his *talwar* (sword) had been taken away; my plane-table ruler, my sketch-book, and some other small things, had also disappeared. We fortunately caught sight of his *talwar* in the hands of one of the men, and the Khan at once ordered its return, and assured us that everything should be restored. I am afraid we did not quite believe him, but we pretended to do so, and were only too glad to see the bulk of our property safe. We soon after continued our travels and reached Hisárak at about seven o'clock in the morning. We were taken to a large new-looking fort, into the garden of which we were conducted, and here we found the Khan sitting on carpets spread under a beautiful palm-tree, immediately over the broad bed of the Aozangani, just above its junction with the Surkhab, which flowed close to the other side of the fort. He rose to meet us, and received us very civilly, apologising for what had happened, and saying he was afraid we must have been put to great inconvenience.

We volunteered to make a fresh start the next morning, but it was decided that it was too late, some of our troops having already started for India; and it was feared that when the Afghans really saw us on our way back, there might be danger of small detached parties being cut up. For the same reason any trip into the Siah Koh was not thought advisable, and so our work was finally closed, with the exception of the filling in of a gap to the south-west of Jelalabad, which was done by Mr. Scott with a strong cavalry escort.

Return to Jelalabad.

I again joined General Macpherson's brigade on its way back, and reached Jelalabad on June 5th. During the afternoon, when arranging for the removal of the instruments, &c., left in depôt there, I heard of Colonel Tanner's arrival from the Kunar valley. He soon after joined me in the fort, where we obtained quarters. I found he had been as far as Aret in Chuganistán, where he had been taken ill, and had eventually been obliged to return on account of his health. His opportune arrival was mere accident, for he had heard nothing of the orders to return to India, and was consequently much astonished to find me at Jelalabad. He was still very weak, so I was glad to be able to arrange for a raft to float us down to Dakka, and thus saved three very hot tiresome marches, besides having two days' rest at Jelalabad in comparatively comfortable quarters, whilst our men and mules were marching.

Extract from Report by CAPTAIN E. P. LEACH, R.E., *late on special duty with the Peshávar Column, Afghan Field Force, dated Simla, the 22nd August* 1879.

I HAVE the honor to submit the following report upon my own personal share in the survey operations of the Peshawar column, Afghan Field Force.

2. The survey of the Khyber and surrounding hills, the routes followed by General Maude from Jamrúd, and the detachments from Ali Musjid to the Bazar valley, and the subsequent surveys of the Kabul river and Shilman valleys, ending in the attack upon the survey party near Michni, fell to Mr. Scott. Major Tanner and the late Captain Samuells conducted the route survey as far as Jelalabad, and the former officer, with Captain C. Strahan, R.E., completed the survey of that route to its limiting point, Gundamuk, as well as an exploration

of the surrounding country northwards to the Siah Koh, westwards to the Sufed Sang hills, and southwards towards the Sufed Koh. Individually I had the privilege of accompanying General Tytler upon the second Bazar valley expedition, General Jenkins during an expedition into the Lughman valley, and subsequently of being entrusted with the command of a strongly escorted party detached from Jelalabad for the purpose of reconnoitring the various passes over the Sufed Koh into the Kuram and Bárá valleys, and generally extending the survey operations into the Shinwari country, intermediate between Mazina and Pesh Bolak.

3. A wound received during this latter expedition compelled me most reluctantly to resign all further share in the operations of the force, and at the end of March, upon relief by Captain Strahan, I returned to Basawal and subsequently to Peshawar.

4. The survey of the Jelalabad valley and a strip of country extending northwards to the foot of the Kunar hills and southwards to the lower ranges of the Sufed Koh was completed simultaneously with the advance of the troops, but for many weeks afterwards little was added. The peculiar glacis-like formation of the northern spurs of this latter range completely covered the defiles leading into the "daras" or passes from distant observation. The villages and forts guarding them lay securely imbedded in the almost artificial channels formed by the mountain torrents in their passage through the conglomerate formation of the outlying hills, while, to add to the difficulties of the surveyor, an entire absence of vegetation and a tendency on the part of every stream to divide itself into a series of high and low level channels precluded any attempt at an accurate sketch without actual survey.

5. The two expeditions into the Bazar valley promised opportunities of exploring the summer quarters of the Afridi tribes in the Teráh Maidan at the head of the Bárá valley, but upon both occasions it was not considered expedient to force survey at the risk of opposition, and the chance was lost. The deficiency has, however, been supplied to a certain extent from native information collected on the spot by Mr. Scott, as alluded to in a subsequent paragraph.

6. The valley of the Kunar, rich in historical and antiquarian interest, and an important line of communication with Chitral and the great Pamir *viâ* the Baroghil pass, was also forbidden ground, as also the Momand country north of the Kabul river.

7. The expedition into the Lughman valley proved more successful, a good survey being obtained of the courses of the Alishang and Alingar rivers and western spurs of Káshmim, a high mass of snowy peaks immediately overhanging Besut and Jelalabad. Within easy riding distance of the standing camp at Tirgarhi, the point of junction of these two streams, lay Badiábád (the fort in which the captives were imprisoned by Mahomed Akbar Khan during the first Afghan war) and the celebrated shrine of Metar Lam, the reputed father of Noah.

Judged by the depth of water in their respective channels, the Alingar is by far the larger stream, and an exploration of its course as far as Badiábád, close to which the river bends round to the north, would probably have given it a more extensive drainage area than that shown upon the existing map.

11. Leaving Calcutta on the 29th December, I reported my arrival at Jamrud on the 5th January, and proceeded the following morning to join Major Tanner with the head-quarters of the first division at Jelalabad.

12. On the 17th January I again left Jelalabad with a detachment under Colonel Newdigate, Rifle Brigade, to join a force of all arms under General Tytler, proceeding to the Bazar valley. During the march to Basawal with a small escort of Ghoorkhas, I made several short excursions right and left of the road, ascending the most prominent points, and gaining a fair general idea of our subsequent line of march to Bazar. A halt of a week at Basawal also enabled me to work over the hills above Hazar Nao, a large village on the road to Dakha, but an attempt to ascend the high range called "Be-daulat," facing the camp on the opposite bank of the Kabul river, was unsuccessful, and subsequently disallowed.

The stratification of this and the adjoining ranges of "Mar-koh" and "Matu" is almost vertical, and points to violent volcanic action at some remote period. The hills themselves are oolitic limestone, and at the eastern extremity of "Be-daulat" are a series of rock-cut caves close to the village of Chaknawar. According to Masson the whole neighbourhood abounds with indications of old sepulchral localities. Mounds and tunnels exist at Chaknawar itself, and also at Chardih, a large village on the skirts of the "Mar-koh" hills. The gorge through which the river forces its way between the villages of Ambarkhana and Ragna is extremely picturesque.

13. On the 20th January I proceeded with Captain Kinloch, A.Q.M.G., to a point of the "Amarkot" hill, six miles south of Basawal. Our object was to fix the position of two Shinwari cave villages, Raja Miana and Nikati Miana, against which a night expedition was being organized. This expedition I accompanied on the 22nd. The distance from Basawal was about 13 miles. The road lay over broken boulders and rough undulating hills rising gradually to the spurs of the "Sufed Koh," at the foot of which, cut out of the side of a deep ravine, lay the two villages. The surprise was successful. A detachment of about 200 men, consisting of Rifle Brigade, 17th Foot, 4th Goorkhas, and Guide cavalry, succeeded in surrounding the villages before dawn, and at daybreak the alarm was given. The Shinwaris, whose implication in a murder committed near the camp a few days before had been clearly established, turned out to find themselves hemmed in on all sides. The majority ran the gauntlet of the whole line of "Martinis," and made for the hills, but, thanks to an attempt made to save the women, the greater number escaped. The remainder were taken prisoners, and the little force, with its gang of captives and twelve hundred head of cattle, made the best of its way back to Basawal. A short half hour was allowed for survey. The

scene on the return march was a curious one. In one direction a guide sowar in full chase after a herd of cattle, riding down and turning his spoil in the most scientific manner, in another a party of Ghoorkhas equally intent upon the capture of some sheep; in the fore ground the long line of Shinwari captives; in the background their women, who very soon recovering from their fright, and finding that they would be unmolested, followed the rear of the column closely, and in their mother-tongue breathed loud imprecations upon the Ghoorkha sepoys.

14. The 25th January was the day fixed for the general move upon Bazar, the first night's halt being at Chunar, a Shinwari village that had been attacked and burnt during the preceding month. Making a detour round the eastern extremity of the "Amarkot" hill, while Lieutenant Peacock, R.E., conducted the route survey, I filled in a considerable amount of the detail of the low-lying hills, and reached Chunar late after a march of 18 miles. The rise had been gradual, over low rolling masses of conglomerate devoid of vegetation, and a barometer reading gave the height of Chunar 3,500 feet. No opposition was met with. Several cave villages were passed on the road and burnt, but their owners had fled. The next day a portion of the force advanced on Kasaba, a small village three miles south-west of Chunar, camp being struck, and the baggage started for Sisobi, at the foot of the pass of the same name. Kasaba was found deserted, but its inmates opened fire from the sides of a precipitous and pine-clad spur of the Sufed Koh immediately overhanging the valley, in which its towers were the prominent feature. The Ghoorkhas were sent in pursuit, while the Sappers duly mined the towers. Scaling the precipitous cliffs, the sepoys were very soon on shooting terms, and puff after puff marked the retreat of the Shinwaris. A few minutes later a loud report and deep thud, followed by a second, proclaimed the fate of the two towers. The Ghoorkhas were recalled, and Chenar reached before noon without accident or casualty.

15. The hills as far as Chenar were absolutely devoid of vegetation, and looking back over the plain of Jelalabad, the higher ranges stood darkly out of what appeared to be a waste of sand, burying their lower spurs and sloping gradually downwards towards the Kabul river. These sloping valleys are a peculiar feature of the country; but I regret that my geological knowledge is not sufficient to enable me to form any definite conclusion as to their origin, nor have I been able to find them alluded to in the various works descriptive of the country. From the Basawal side the road to Chenar lay through a deep and difficult gorge, but towards Dakha it was easy and easily defensible. Leaving Chenar, a descent of about a mile into the bed of the Tsitsobi stream completely changed the scenery. A broad track along the bed of the river led up to the village where the camp was already pitched. On either side of the road the hills rose precipitously, a magnificent gorge under the hill called "Tungheh" being particularly striking. As the valley advanced the cliffs receded, and round the village of Tsitsobi a certain extent of terraced cultivation formed a contrast to the sombre colouring of the rocks in the background.

The advance of the little column might easily have been contested, the low spurs being covered with undergrowth, but Tsitsobi, like Kasála and Chenar, was found deserted, and as our guides had been obtained from here, its towers were spared. The height by barometer was 3,750 feet.

16. On the 27th, having the pass to cross, an early start was made. The distance to the foot was about a mile, still through cultivation, and then a stiff zig-zag ascent of 1,000 feet gained the summit of the range. The view was magnificent. An escort of twenty men had as usual been provided for me, and with them I worked my way along the ridge to our left, hoping to fix some of the peaks on the Bara range. The height of the pass was approximately 4,800 feet, and I reached a point about 6,000, from which the distant peaks of the Kabul range and the snowy points of "Nijran" and "Kund" were distinctly visible; but in the direction of Bara the intervening "surghar" closed the view, and I had no time to reach a higher elevation. The descent on the southern side was more gradual, leading into the open valley of the "Serwo Kai." The hill-sides, wooded and precipitous, terminated in a grassy plain, with scant patches of cultivation here and there, and commanded by an isolated group of barren rocks, locally called Chinaghar. At the southern side of this hill lay the village of China, and a short distance further the camp of General Maude and the troops from Jamrud. The length of the march had been about seven miles, and the height of the camp was about 3,750 feet.

17. The camp had been pitched on the edge of a deep stream leading westwards towards the pass into the Bárá valley. Crossing the stream to the south, a series of low spurs heavily wooded ran down from the "surghar" range, and those were turned to considerable advantage by the Afridis, who, descending from the main range at night, kept up a desultory fire upon the camp. Along the stream lay the road to Bara and the small villages of Halwai and Bokar.

18. On the 28th a reconnoissance in force, under the personal superintendence of General Maude, was made in this direction. The temper of the Zukka Khels was uncertain. It was rumoured that our progress would be opposed, and the strength of the column was accordingly increased to 1,000 men.

Both Mr. Scott and myself were out, but it was soon evident that it would not be altogether a survey day. The Afridis, who had gathered in some strength, opened fire from the hills on the right bank of the stream before we had advanced two miles from camp. This necessitated a halt. The guns were brought up, and under cover of a few shells the Ghoorkhas advanced to dislodge them. This was effected with trifling loss, the force advanced, and the enemy, gradually driven from hill to hill, withdrew to the main range.

22. An expedition which Major Tanner and myself had contemplated up the Kunar valley was again deferred owing to political complications; and no further military operations being in prospect, I obtained permission from Sir Sam Browne to make an attempt to penetrate into the Shinwari country south of Jelalabad, under the protection of the Khan of Mahrez.

Mr. Jenkins, c.s., Political Assistant to Major Cavagnari, had a few weeks previously been taken to the fort of the Papin Pass, and both Major Tanner and myself had made several single-day trips as far as the large village of Daolatzai in the same direction.

A small escort of 30 Ghoorkhas and some guide Cavalry was placed at my disposal, and eventually General Macpherson, Major Tanner, and two other officers joined the party. Supplies were taken for four days, and the only stipulation made was that we were not to advance against the advice of our Shinwari guide, the Khan of Mahrez.

Whether the extra responsibility entailed by the presence of the General, or a little pressure brought to bear by the inhabitants of Mazina (where our camp was pitched for the night), induced the Khan to waver in his undertaking, remained to be proved. The next morning, however, we were civilly told that we could go no further; and the Khan informed us that if we persisted in making an onward move he should return to Jelalabad. He even declined to approve of a second night's halt at Mazina, or of any expeditions from thence into the surrounding hills. The reason given was that some private grudge against himself might be made the excuse for a night attack upon our small camp; but there is little doubt that the true cause was to be found elsewhere, and that the uncertainty as to how long our troops would remain in the valley prevented many of the peacefully inclined chiefs from tendering their allegiance and assisting, as they would doubtless otherwise have done, the exploration of their country. A council of war was accordingly held, and it was decided not to oppose the wishes of the Khan, but to move down the valley of the Papin river in the direction of Barikab, one of the standing camps along the line of march.

23. Our project had failed, but we were relieved from our disappointment by a message from Jelalabad announcing the departure of General Jenkins the next day with a considerable force into the Lughman valley. As this offered a prospect of opening up an entirely new line of country, and little was to be gained by a continuance of our present connection with the Shinwaris, orders were given to march on Jelalabad, and preparations made for an early start the next morning with the Lughman force. A day's delay gave us a little breathing time, and as our baggage animals had had a double march the day before, and a long march lay before them, we were not sorry to avail ourselves of the temporary halt.

24. The nominal object of this expedition was to reassure the Lughmans, many of whom were inclined to side with a powerful Gilzai chief, Asmatulah Khan, who from the first appearance of our troops at Jelalabad had been openly instrumental in raising the Momands and other doubtful tribes against us. A secondary object was perhaps the capture of the chief himself.

No opposition was expected from the majority of the Lughman chiefs, but contingencies were provided against, and heliographic signalling maintained with Jelalabad. The force consisted of detachments from the Rifle Brigade, 10th Hussars, Goorkhas, and Corps of Guides, and was accompanied by Major Cavagnari in person.

25. Crossing the river at Jelalabad, the column passed through the populous district of Besat and entered the low hills separating the cultivated lands on the left bank of the Kabul from the Dasht-i-Gamberi, a desert tract extending northwards to the slopes of Kashmir. I had no opportunity of examining this portion of the valley, but viewed from a distance not a vestige of vegetation was visible, and the course of the streams draining its barren surface was barely discernible. Major Tanner describes it as a waterless plain, 10 to 12 miles long and 3 to 4 miles broad, composed of alluvium and sand.

26. A somewhat fatiguing march over low rolling hills of conglomerate brought us to Daronta, a distance of 10 miles, where the river, forcing its way through a deep gorge at the eastern extremity of the Siah Koh range, leaves the Lughman and enters the Jelalabad valley. The gorge is about half a mile in length, and the breadth of the river 70 to 80 yards. The rocks on either side are almost precipitous, but a track crosses the range at a height of about 400 feet above the river, and is used as a short cut to Jelalabad from the Kach district, in which is situate the fort of Asmatullah Khan. I had explored the route a few days previously, and made a careful survey of the gorge, with a view to avoid turning the Jagdallak range by a more direct route along the Kabul river. There is no doubt that this might have been done. One of the most frequented routes to Kabul is *viâ* the Lughman valley to Mandrawar, and thence directly up the valley of the Kabul river. The distance saved according to a reconnaissance by some disguised sowars of the guide cavalry would be about 22 miles over the more circuitous route by Jagdalak and Butkhák, and the only pass described by the sowars as practicable for guns in its present state lies over the watershed between the Nigrasi and Tagan valley.

27. The Siah Koh range, according to Masson, is variously called Kandajhar by Afghans, Baghatak by Tajiks, and Koh Bolan by Lughmanis. The latter name was certainly as freely used as its more generally known designation Siah Koh. Masson describes the whole range as abounding in ancient remains, and several topes were opened and examined by him in the neighbourhood of Daronta. Masson's travels are well worth reading, and in his first volume will be found descriptions of almost the whole of the ground passed over during the present expedition. He was apparently free to follow his own

inclinations, and during several years' residence in Kabul and its neighbourhood seems to have explored the greater part of Northern Afghanistan.

28. Masson to this day is well recollected by the older men in the villages near these topes, and from their account as well as his own carried off a considerable amount of buried treasure. Mr. Simpson, the special artist of the *Illustrated*, and Major Tannere, took in hand the excavation of the topes at Ahni Posh near Jelalabad and Hadda, and fortunately hit upon one which had not been excavated by Masson; but a large tope near Char-deh, mentioned by Masson as left unopened, was perhaps unfortunately passed over.

29. From Daronta the road to Lughman for several miles follows the left bank of the Kabul. The river rapidly widens out to a breadth of nearly a mile. It is fordable in places, but all the fords require a local guide, and their practicability depends entirely upon the height of the river. Below the Daronta gorge is a ferry, which is largely used by travellers passing from Lughman to Jelalabad, the road being more direct and far easier than that followed by the troops through Besut.

Guarding the road, and on the left bank of the stream immediately above the gorge, are the remains of ancient walls and parapets, called Kafir Killa.

Our camp for the night was at Kalatik, about a mile beyond the large village of Chárbagh, the capital of the district.

30. Next day the column moved to Tirgarhi, at the junction of the Alishang and Alingar rivers; and as no opposition had been offered, I was given an escort of "Guides," and with Captain Battye of that corps ascended the high range of hills north of Chárbagh, and following the ridge for some little distance, again descended and reached camp at sundown. Our elevation had been about 5,000 feet, and the day being clear, the view was magnificent. At our feet lay the two valleys of the Alingar and Alishang, the white boulders in the beds of the streams marking their courses through a network of villages and cultivation. Looking north, the sharp peaks of the Koh Karinj formed the limit of the Alingar valley, which, running for about 10 miles in a north-east direction, gradually trended to the north and was lost to view. A belt of cultivation about two miles across, thickly studded with fortified villages, extended as far as the eye could reach from the junction of the two streams. On the northern slopes of the Koh Karinj lie the villages of the Siahposh (black skin) Kafirs, so called from the black sheep-skin usually worn. Up the Alingar stream, in the extreme distance, we were pointed out the fort of Badiábad, a place of historical celebrity in connection with the captives of the first Afghan war; while over the Alishang towered the snowy peak of Nijran Great Trigonometrical Station, a most important landmark throughout the Kabul valley. Further west lay the valleys of Nijran and Tagan, separated by a low range forming a connecting chain with the Siah Koh, and through which, as at Daronta, the Kabul finds its way in a deep gorge. The former is of comparatively small extent, but Masson describes the Tagan valley as highly cultivated and of considerable size. The inhabitants of both are Tajiks, and both are full of the usual sepulchral remains. To the south the Lughman valley is limited by the Siah Koh, over which towered the distant peaks of the Safed Koh, all at the time of our visit completely buried in snow. A day or two later a heavy fall had covered the Koh Karinj, the range on which we stood, and the dark peaks south of us; but the year had been a mild one, and it soon disappeared.

31. Five miles distant from Tirgarhi is the shrine or *ziarat* of Metar Lam, previously alluded to. The tomb is 16 yards long and 2 yards broad, and according to the Lughmanis whoever is buried within its precincts is sure of paradise.

The traditions concerning it are numerous, and it is universally believed (says Masson) that the Kafirs stealthily, and by night, visit the *ziarat*.

Three large rivers flow through Kafiristan from north to south, and augment with their waters the rivers of Kabul and Jelalabad. The two westernly ones (Alishang and Alingar) unite at Tirgari of Lughman. The easternly river known as Kámeh (Kunar) falls into the Kabul east of Jelalabad . . . The Kámeh flows through Chitral, and its source is more remote. On the east it may be considered the boundary of the Siahposh territory, as the rivers of Nadjil and Alishang form the boundary on the west. The sources of the Nadjil are not very distant, and it is the smallest of the three rivers . . . The central river (Alingar) is more considerable. It is the only one which has a peculiar name, or one independent of the localities through which it passes, and is called Kow Kan.

33. From the above it will be seen that no mention is made of any stream corresponding with the large tributary of the Kunar, shown in the existing map of Turkistan as rising south of the Dara Pass and joining it at Chagar-Sarai. It is far more probable that the Alingar drains the whole of this area. Describing the Jelalabad Chitral Kafila route, Masson says:—"There are also many small rivers, or rivulets, which fall into the Kameh "(Kunar) from the west. They generally flow down valleys inhabited by Nimchas or "half-Mahomedans, who are immediate neighbours of the Siahposh, and with whom, as "the case may be, they are in hostility or on amicable terms."

This is exactly what is to be found at the present time. The Chugni tribe, of which Major Tanner will no doubt give a more detailed report, correspond exactly to the "Nimchas" of Masson.

34. The dotted course given to the Kunar river north of Asmar is no doubt the true one, and what is shown as the river is merely the Kafila route. The Bajour range is certainly continuous, and Dir must lie on the banks of a tributary of the Landai river.

The natives of Péch now call themselves Safis, and are independent, but avow themselves to be Mahomedans. It is strange that their neighbours of Dara Nur, and the remote inhabitants of Pagan, who are expressly stated by Baber to have been in his time Kafirs, alike call themselves Safis . . . . . In his recent expedition to Kafiristan, which terminated so unfortunately, it was from these Safis that Major Tanner had most to fear; and whatever they may have been, there is little doubt that they are now completely alienated from the other Kafir tribes.

36. Masson mentions Hishpi (Ishpi) as the largest village of another community originally Kafirs, and considers the inhabitants of Daranúr, Dara Nazár, and all the villages opening upon the Kunar river as originally secessionists from the same race, whence possibly the name.

"It is agreed that the Siahposh place their corpses in deal boxes, and without interring "them expose them on the summits of hills. But it is not explained whether this is a final "disposition. There can be no doubt that the usages of a people with regard to their dead are "important evidences of the faith professed by them. . . . . Thus we are not permitted "to consider a race that does not burn its dead of Hindu faith. From the testimony, how-"ever, of the Siahposh whose fate has made them captives, it is clear that they have some kind "of worship, and that their deity is named Dagon. . . . . .

"The Siahposh are affirmed to build their houses of wood of several stories in height; it is "also said that they are much embellished with carving." . . . .

The carving of the houses in Aret, the nearest village to Kafiristan reached by Major Tanner, was most remarkable, and would indicate the Kafir descent of the Chagnis; but upon this point more information is no doubt forthcoming.

"The testimony of Baber, that they are a social race and indulge freely in wine, is amply "confirmed by the general reports of the present day, and by the fact that their wine is easily "procurable. All that I have seen of it was brought in skins, and so sour as to be undrink-"able . . . . Amongst the similarities imputed by the Mahomedans to the Siahposh "is their objection to sit on the ground, or to take their repast on it, and the custom they have "of using chairs or stools. . . . As to the possibility of opening a communication and estab-"lishing an intercourse with the Siahposh, it is allowed by respectable Mahomedans that there "would be no difficulty, provided the capture and conversion of them were discontinued."

37. Such is Masson's description of the Kafirs, and it will, I think, be found to agree closely with the information gathered by Major Tanner from his Chagni friends. That his attempt should have failed is much to be regretted. The disappointment to himself was most mortifying, but there can be little doubt that upon all such expeditions a companion is essential; and considering the risks run and the difficulties actually overcome, Major Tanner is perhaps to be congratulated on having at least been the first European to show the route by which Kafiristan may eventually be explored.

38. Two days were spent by General Jenkins at Tergarhi, but no expeditions were allowed beyond short distances. Major Cavagnari visited the tomb of Metar Lam with a small escort, and on the 5th day the troops made a forced march and returned to Jelalabad.

39. At the end of February the arrival of the Commander-in-Chief and staff gave Major Tanner an opportunity of submitting the progress of our operations and the limited area of country hitherto surveyed. All that could be done without camping out at night under strong escorts had already been completed. The Kunar valley was our most promising field, but for political reasons it was considered unadvisable to attempt its exploration, although the chief of Kunar, Kaloo Khan, had on several occasions undertaken to be responsible for the safety of a party. The hostility of the Momands precluded any attempt at crossing the Kabul river into the Goshta district opposite Chardeh, while the allegiance of the Khan of Lalpara was so doubtful that no additional survey in that neighbourhood was likely to be successful.

The Shinwari country had not as yet been explored, and although our withdrawal from Mazina on a previous occasion had been rendered necessary owing to the smallness of the escort, the Khan who had accompanied us had signified his willingness to act as guide if a larger force were provided. We had therefore every reason to anticipate that by moving camp from day to day through the low-lying villages which were all peacefully inclined, we should be able to make excursions far enough into the low hills and more doubtful country to obtain all necessary information regarding the passes into Kuram and Bara, and also to obtain from a distance a fair survey of the main range.

40. Major Tanner accordingly pressed upon His Excellency the necessity of my undertaking, if possible, the tract of country extending from Mazina to Pesh Bolak, intending himself to continue the same work westwards. He also urged strongly the practicability of reaching Kafiristan through the Chagni country with the assistance of Kaloo Khan, the Kunar Chief.

41. These proposals were conditionally acceded to, but heavy falls of snow on the higher ranges rendered the passes impassible, and the Chagni guides, who had left camp to return to their own village and had promised to bring some real Kafirs with them, reported the road impracticable.

42. Major Tanner accordingly arranged to start simultaneously with myself in a westernly direction from Daolatzai into the Kogiani (Koh-gani) country.

49. On the 8th March the detachment left Jelalabad and proceeded to Daolatzai, about 12 miles due south. The Khan, Mirza Azim, entertained the whole party most hospitably, and had on a previous occasion given me every assistance in his power. (Height of Daolatzai 3,600 feet.)

50. On the 9th the camp, accompanied by the Ghoorkhas under Lieutenant Adye, marched direct to Mazina, while Lieutenant Hamilton and myself with 50 guide sowars reconnoitred the low hills south of Daolatzai, crossing the Nariobo stream in the neighbourhood of Mahrez, and thence returning to camp down the valley of the Papin. The country we had passed over consisted of low rolling masses of conglomerate, intersected by ravines and devoid of cultivation. We had met with few villages and no opposition. The highest point reached was 5,100 feet.

51. On the 10th, accompanied by Lieutenants Adye and Leach, and escorted by a company of Ghoorkhas, I started up the valley of the Papin. Mazina itself lies in this valley, here at its broadest part, and highly cultivated. Irrigation channels led from the river bed intersect the cultivation in every direction, while the magnificent *chenár* or plane trees give to the valley what the whole valley of the Kabul is so destitute of—an appearance of vegetation. Mazina consists of a collection of about 15 detached walled enclosures. These structures are built on a uniform plan throughout the Shinwari *daras* or valleys. They are usually made of sunburnt brick, enclosing an area of from 50 to 80 yards square. The walls are from 15 to 20 feet high and proportionately thick, and the enclosure is entered by a single entrance, more or less ornamented, according to the wealth of the proprietor. At the opposite angles are bastioned towers, and in the interior the huts of the cultivators and sheds for the cattle. At night the door is closed and the inmates retire to comparative security.

52. The number of these forts and the richness of the crops may be gathered from the fact that between Mazina and Mahree, a distance of about 5 miles, there are nearly 60 of them, each containing from 60 to 100 souls.

From Mazina northwards the valley is continuously cultivated as far as the large town of Barra. Down the valley runs the old road followed by Burner to Peshbolak. Southwards the valley contracts rapidly to a breadth of about half a mile, the general level of the river-bed being from 50 to 60 feet below that of the surrounding country, which is bare and uncultivated.

53. Assuming the valley of Jelalabad to have been originally a level plain, the foot of the Sufed Koh would have been from 16 to 18 miles distant from the Kabul river. The streams may similarly be supposed to have followed a tolerably north and south course, as shewn upon the present map. This, however, is far from being the case. Some violent action has, as it were, convulsed the massive boulders of the higher range, and the *débris* heaped up at its base has gradually been carried lower down the valley, and become cemented into a vast conglomerate bed by the calcareous matter supplied from the limestone strata of the Sufed Koh itself. Calcareous beds underly the conglomerate, and in the neighbourhood of Barra, a few miles south of Barikab, there is a large surface deposit of what appeared to be soft "kunkur," very similar to the natural cement called "khari" of Rajputana.

The mountain torrents, stemmed in their downward course by this wall of natural masonry, have been turned right and left, following out, at the foot of the Sufed Koh, proper deep valleys, and finally cutting their way in deep channels through the conglomerate mass to the Kabul river. These channels again subdivide themselves, and a stream, which has left the higher range in a broad rushing torrent, finds its way into the parent river in a succession of small rivulets. Many of these are dry during the cold season, the whole of the water being diverted for irrigation purposes.

54. The extensive vegetation of the higher spurs supplies the rich soil of the cultivated valleys. Manure is largely used even when the crops are standing, and as the Afghan cooks his food with wood, the whole of the animal refuse returns to the soil.

55. Fruit-trees and vines are abundant. Each fort has its little open grass plot in front of the gateway, where the chief, or *malik*, holds conclave under the shade of a stately *chenár* or walnut. Close by is the village mill, and in every group of forts or village a musjid, which is regularly attended by the men. Judged by the appearance of the Papin Dara, which I explored almost to its head, the Shinwaris are a certainly prosperous and powerful tribe. We were invariably treated with civility, and our guide, as long as we confined our attention to the low-lying or "ryot" villages, had no hesitation in going everywhere.

56. As Major Tanner had arranged to take the country west of Daolatzai, I had not explored the valley of the Chapriar stream, leading into the Kogiani country, and thence to the Agam pass. In the absence of other information, however, the following route may be of value. The distances were given in *kos*, but the value of the unit may easily be determined between the limiting points, Daolatzai and the top of the pass:—

From Azim Khan's fort ...	To Golam Russool's fort ...	Shinwari tribe	2	*kos*	distance.
	„ Moulla Nazir Kalai ...	„	3	„	
	„ Kazi Miaji	„	4	„	
	„ Mann	Tajik tribe	5	„	
	„ Maura	„	6	„	
	„ Kuz Sabar	Kogiani tribe	7	„	
	„ Bar Sabar	„	8	„	
	„ Agam	„	9	„	

57. To return to my narrative. Leaving Mazina we crossed the stream, and, following the ridge along its right bank, passed in succession the villages of Khano, Shpola, Yaghiband, Shekmaidan, and Charwazai. We struck across the low undulating plateau to our left, and made for a high point commanding the entrances to the Papin and Oghaz passes. As we approached the hill, several men were seen to leave it and descend into the valley below, and soon after *tomtoms* were heard beating in the villages nearest us.

By the Khan's advice I moved off the road to the right, and ascended the high point. Our guide's conduct had been somewhat suspicious. We were close to his own village of Mahrez, and he had previously told me that he was at feud with his immediate neighbours, and these villages in particular, and had alleged this as a reason for not wishing to go on. Meantime several armed men had collected on the hills above the village, but considerably below us, and there was evidently one of the number who, from his excited manner, appeared to be inciting the others to hostile measures. I accordingly sent the Khan down to explain the object of my visit, and to intimate that strong measures would be resorted to if shots were fired. This he did, and after a short parley the Shinwaris retired to the village, and a number of them came up the hill to see what I was going to do; eventually escorting me as far as Mahrez, the Khan's village.

On enquiring from the Khan the cause of this hostile demonstration, he told me laughingly that a madman in the village had tried to persuade his comrades to attack the party, not knowing what the presence of my small body of Ghoorkhas meant, but that he had had no difficulty in arranging matters.

Having finished my work, I stayed half an hour in his village. Russian cups and saucers, Russian tea, and Russian sugar, were produced, and having refreshed ourselves and made the acquaintance of his family generally, we returned to camp.

58. The above incident shows how easily a collision may be brought about, and how easily avoided. Had I allowed the Khan to leave me, as he was anxious to do, there is little doubt that I might have found myself involved in a fight, in which neither party had really any wish to share.

Since the appearance of the troops at Jelalabad, no armed force had attempted to enter the Shinwari country. My arrival was therefore looked upon with extreme suspicion, and as none of the Shinwari chiefs had come in, the hostility of the villages was to a certain extent natural.

59. At Mahrez, the height of which was about 4,400 feet, the main stream is joined by another broad torrent flowing from the Oghaz kandoo or pass. Both valleys are thickly populated. The entrance to both passes are, I think, shown upon the original plane-table sections, and, as far as I can recollect, the names of the intermediate villages.

Leaving Mahrez and following the minor stream, these villages are Raogeh, Kotawal, Ahmed Khel, Dehbula, Thugeh, and Oghaz.

Of these by far the largest is Oghaz, which numbers some 30 or 40 forts, and lies within the gorge through which the torrent enters the Sufed Koh range; Dehbula, containing about 20 forts, is situate on a flat spur immediately to the left of the gorge, and its towns and cultivation were distinctly visible. The whole of these villages are Shinwari. The Oghaz pass is a mere track over a depression in the main range, and it is little used. The Maman pass, at the head of the Kodara, and the Papin, are both passable for pack-bullocks, but the easiest and most frequented is the Agam, at the head of the Chapriar river. Unfortunately none of these passes could be explored and accurately reported upon. The names of these passes are strictly local. The Papin takes its name from a large Degan village two and a half miles from Mahrez, numbering from 16 to 20 forts. Close to Papin is the Moulla village of Kaskai, and at the entrance of the gorge the large Shinwari village of Gurgusai on the right bank of the stream, and Shabi, a Kajiani village, on the left, immediately opposite to it.

I was unable to trace the course of the Nariobo, a large deep stream flowing under the southern spurs of Chajash, a range of conglomerate hills rising to a height of 6,000 feet and separating the Papin from Agam. 'dara'; but its bed was uncultivated, and contained no villages till it reached the neighbourhood of Mazina.

61. On the 13th, supplies falling short, I marched down the Mazina valley to Barikab, having telegraphed for extra rations to be sent me from Basawal. Wet weather again set in, and, much to my regret, my Goorkha escort was withdrawn, and their place supplied by 100 men of the 45th Sikhs, under the late Lieutenant Barclay. Twenty sowars of the Guide Cavalry were also returned to Jelalabad, and my escort was then considerably weakened. For three days incessant rain prevented our leaving Barikab, but during the temporary halt I had an opportunity of seeing Sir Sam Browne on his return from Peshawar, and also gained time for making arrangements with the maliks of Kot. Kot, or properly speaking the Kot Dara, commences at a Syud village called Zerbatcha, and running in a south by south-west direction enters the Sahed Kot about two miles east of Dehbila, terminating in the Maman pass. Like the Papin Dara, it is extensively cultivated and thickly populated.

62. The Shinwari chief Yar Mahomed had expressed his inability to assist me in any way on private grounds, and I had therefore to make other arrangments. A guard of 40 men belonging to the Kot villages had for some weeks past been entertained by Government, and through their headman I had no difficulty in persuading two maliks to come in. They offered at once to escort me as far as their own villages, some five miles higher up the stream than Zerbatcha, and this I considered would be far enough for my purposes. During my stay at Mazina a pensioned subadar of the 24th Native Infantry paid me a visit, and as he was a Shinwari by birth I was able to obtain from him a good deal of information concerning the country we were going into. He confirmed my guide's statement that his authority would not pass me through Kot, and approved of the course I had taken in sending for the maliks themselves.

63. During this time the sapper subadar, Hyder Khan, had been of the greatest use to me, and his knowledge of the people and their language had on several occasions helped me most materially. I found, however, that my own want of knowledge of Persian was a great

drawback. The maliks were especially suspicious, and although they could have conversed freely with me in that language, they objected to be interrogated through an interpreter. I found the same to be the case with Yar Mahomed Khan.

64. On the 16th the camp marched to Zerbatcha, and every attention was at once shown us by the Syud chief. I intended that day to push up the Kot valley, and the next to work southwards into the low hills near Maidanak. Beyond Zerbatcha the most influential chief was Umrah Khan of Chilgazai; and as I discovered that my permanent guide, Yar Mahomed Khan, was related to him, and the two Kot maliks recommended him as the most likely chief to come in, I left Yar Mahomed Khan in camp to make the necessary arrangements.

65. I then started with 50 sowars, Guide Cavalry under Lieutenant Hamilton, and the two maliks, who by way of precaution had produced about 20 matchlock-men from their own village. Having proceeded about five miles, we reached the limit agreed to by the maliks. A low, isolated hill in the centre of the valley gave me a capital position for my plane-table, and the whole 'dara' up to its junction with the higher range, which I had previously fixed, lay at our feet. The cultivation on both sides the stream extended close up to the hills and as far as the eye could reach. Our Shinwari friends chatted away and gave every information without hesitation. On the way home I crossed the stream, and ascending the hills on the left bank completed a fair amount of work before it was time to return to camp.

66. During my absence the Chilgazai chief had been to the camp, and had left word with Yar Mahomed Khan that he was willing to take charge of me if I would meet him at his own village the next morning, but he asked me not to move the camp itself. It would have been more convenient to have done so, but as matters eventually turned out it was most fortunate that we did not.

67. The next morning, 17th March, I arranged with Lieutenant Hamilton to start again with his sowars, and put my two khalassies with the plane-table, &c., on mules. Lieutenant Barclay soon afterwards expressed a wish to accompany us, and at Lieutenant Hamilton's request I assented, as the Guide horses had had a long day's work the day before.

68. Yar Mahomed Khan started with us, and after a short march of four miles through rich cultivation we reached Chilgazai. As soon as Umrah Khan made his appearance, I pointed out the hill over Maidanak as the point for which I wished to make, and asked him if he was willing to escort us. He at first demurred, saying that the hills were bare and that there was nothing to be seen from them, and suggested in preference that we should move directly up the valley in the direction of Dehsarak, where General Tytler's force was attacked a few days later. Upon my representing that my work could best be done from the hills, and that no advantage would be gained by a move through the low ground, he made no further objection, but stipulated that he was not to be held responsible if shots were fired at us by *budmashes*, who, as he said, from some private grudge against himself might seize the opportunity of getting him into trouble. As the same conditions had been granted to Yar Mahomed Khan and the Kot maliks, and were in strict accordance with my own instructions, I agreed, and a start was made. Yar Mahomed Khan excused himself, as he said he had lent his horse to Umrah Khan, and as I could not mount the Chilgazai chief myself, he remained in camp.

69. No allusion was made by either Umrah Khan or Yar Mahomed Khan to a possible attack from the villages, and I believe that both Lieutenants Hamilton and Barclay were in accord with me in thinking the expedition a safe one. The only circumstances that might have raised a suspicion of foul play were the facts that Umrah Khan did not produce any of his own men, as he had been told to do, and just before reaching the hill asked leave to follow us, as he wished to say a prayer near some local place of worship. To this I objected, and he accordingly remained. He accounted for the absence of his own men, as he said they were told to follow, and had probably taken a shorter route. The distance from Chilgazai to the hill was about four miles over low, undulating hills intersected by dry ravines. The party consisted of 30 Guide sowars, 40 sepoys of the 45th Sikhs, a native doctor, Subadar Hyder Khan, and the Chilgazai chief, accompanied by two Hindus, one of whom had been a sepoy in our own service. These two men behaved extremely well, and were subsequently instrumental in bringing in the body of a havildar of the 45th, and in giving full information concerning the villages implicated in the attack. They constantly visited me at Basawal, and although their statements at the time were not credited by Major Conolly, the Political Officer, they were afterwards fully substantiated in every particular.

70. Up to the time of reaching the hill not a man had been seen; but the moment we showed ourselves and came in sight of the villages below, there was a general movement made in our direction by about 200 armed men, who were evidently prepared to receive us, and were, I believe, subsequently joined by some more from the villages of Girdi and Batan. All these men came from the village of Maidanak, which lay below us at a distance of about $1\frac{1}{2}$ miles. It subsequently transpired that some men from Maidanak were in the village of Chilgazai during our halt there, and as soon as we moved towards the hills returned straight to their own village. This fully accounts for the little time that elapsed between our appearance over the village and their hostile advance. Guided by my experience at Mahrez, I at once told Umrah Khan to go and meet them, retaining my position on the hill till I saw what the result of this meeting would be. Lieutenants Hamilton and Barclay were both of opinion that we ought at once to make for the open ground and gain as much time as possible. To this course I was opposed, as it would in my opinion have at once precipitated the collision we were so anxious to avoid. We had three miles of low hill to traverse, and the Shinwaris advancing rapidly on our flank must have come within shot before we could reach the Zerbatcha valley. If it came to a fight, I considered that I should be able to hold my own with 70 rifles against a half-

armed rabble of three times the number; whereas if Umrah Khan succeeded, as Yar Mahomed Khan had done at Mahrez, in compromising matters, my survey work might have been advanced the next day, without danger, further south.

71. The Guide Cavalry were halted at the foot of the hill on a ridge, a deep ravine lying between us. Sending Lieutenant Hamilton to join them, I instructed him, in case of a retreat being necessary, to take a straight line to the open ground, while Lieutenant Barclay and myself followed with the Sikhs.

72. In a few minutes the issue was no longer doubtful. Umrah Khan reached the Shinwaris, a short parley ensued, and, firing shots in the air, the attack commenced.

73. With the subsequent events you are already acquainted. The conduct of both officers and men elicited a warm acknowledgment from Lieutenant-General Sir Sam Browne, and, but for the untimely death of Lieutenant Barclay, who was mortally wounded at the last attack, I would have had little to reproach myself with. A chance shot from a jezzail cut short a life full of promise, and by his death the service lost a most gallant officer, and many a brother soldier a true friend. From the first there was little hope of his recovery, and after ten days of severe suffering he died at Landi Kotal. In paying this last tribute, to his memory, I would add that no officer could have displayed more coolness or presence of mind under what, for a short time, were most trying circumstances.

Extracts from report by MR. G. B. SCOTT, *Surveyor, 3rd grade, dated Murree, 23rd June* 1879.

WHILE working in the Murree tehsil, district Rawalpindi, I received a telegram on 24th October directing me to proceed to Peshawar and report myself to Major Cavagnari, C.S.I. Subsequently I received instructions to place myself under Major Tanner's orders.

Preliminary observations.

I commenced work on 1st November by searching for Great Trigonometrical Survey stations in cantonment and city, and started a series of triangulation by observations from the Gurkati, Residency and Fort stations, and on the church spire. From thence I proceeded to Muthra thana, where I took a theodolite observation; thence to Jamrud, where I reported my arrival to Major Cavagnari on 6th November.

On 7th—I took a theodolite observation on Kaosar dheir, a mound of considerable height near Harri Singh ki Boorj.

8th—I accompanied a reconnaissance under Colonel Jenkins, Commandant, "Corps of Guides," to Besai, where I took a theodolite observation; also took a theodolite observation on Jamrúd fort on return to camp.

Having now sufficient data, I computed the sides of several triangles, and plotting the stations and points necessary, commenced plane-table operations on 11th November, when accompanying a reconnaissance made by Major Cavagnari to the Sarkai, peak, from which a view of Ali Musjid and neighbourhood was obtained.

First trip to examine Tartara route.

On the evening of 5th December I received orders to proceed *vid* Lundi Kotal to the Shilman valleys to survey the neighbourhood and examine the state of, the Tartara from Peshawar to Dakha, with reference to the adoption of an alternative route for the conveyance of stores, &c., to and from the front. I accordingly started for Lundikhana on the 6th, surveying *en route*.

7th.—Visited and surveyed round the Buddhist Fort near Khargali, then proceeded to Lundi Kotal. A company of 27th Native Infantry having been told off to accompany me with one week's supply of rations, I proceeded to upper end of Loargi valley.

9th.—Went on to Kam Shilman, and during the next six days, *i.e.* to 15th, surveyed such portions of the country near Tartara route as I was able to do. Owing to having camels to carry my sepoys' tents and rations, and the road from Prangdanah to Kam Dakha westwards, and along the northern slopes of Tartara eastwards, being impracticable for those animals in its present state, I was obliged to return *vid* Lundikhana to Dakha without fully completing the survey. Before doing so I took theodolite observations on Tarsapper at Great Trigonometrical Survey stations Nos. 142 and 143, and on a hill above Lundi Kotal.

First bazar expedition.

On 18th—I was requested by Colonel Macgregor, Assistant Quartermaster-General, to return to Ali Musjid for the purpose of accompanying an expedition into the Bazar valley under General Maude, V.C., C.B. Captain Samuells was returning to Peshawar the same day, sick, so I accompanied him that day to Lundikhana, and the next to Ali Musjid. The expeditionary column was to start from this place, so I was compelled to remain. Captain Samuells went on under the care of Dr. Ryan and an Artillery Surgeon. On evening of the 19th I started with General Maude's column, and remained with it till its return on 22nd, surveying as much of the Bazar and Chura valleys as time and circumstances permitted.

23rd.—I rode into Peshawar to see Captain Samuells, and hearing of that gentleman's death remained there on 24th to see about his property, and to discharge the khalasees of his squad, as they were unwilling to return across the border, the deaths of five of my men, who were from the same part of the country as themselves, having terrified them. Being fatigued, I now asked for and obtained a week's leave, and returned to Jamrúd on 31st December.

From 1st to 3rd January.—I was employed between Jamrúd and Ali Musjid, with reference to the choosing of useful positions for posting pickets of levies to guard the line of march, and to choose alternative baggage routes.

6th to 9th.—Accompanied by Mr. Sinclair, Assistant Commissioner, I marched along the Tartara route from Shahgai to Loi Shilman, surveying the northern slopes of Tartara and taking trips to all difficult places along the river bank; measured the breadth of river at certain points, and examined all the rocky scarps, with reference to future road making possibilities and difficulties.

On 9th—I received a letter from Colonel Heathcoate, Assistant Quartermaster-General, with General Maude's division, telling me that it was intended to make several reconnoissances towards Bazar, and requesting me to return to Jamrúd as soon as possible. Accordingly Mr. Sinclair arranged with the Tarakzai chiefs from near Michni to escort us across the river and back to Michni by the Shinilo, a hitherto unsurveyed route. Unfortunately the boat at the Shinilo ferry had been destroyed, and only one small raft was procurable. I therefore decided to send my escort with their train of mules to Dakha, and started with a few khalasees to the ferry. Mr. Sinclair and I were with some difficulty ferried across, but we were unable to get my men across. Luckily Mr. Sinclair procured the services of two criminal outlaws seeking pardon to carry my plane-table, and carrying the rest of my instruments and my rifle and cartridges myself, we pushed on in company with the Tarakzai chiefs. I surveyed along the route till darkness prevented further observation, and we were obliged to push on during the night to Michni, leaving some seven miles of the route unsurveyed. Next day I returned to Jamrúd.

Examining routes into Bazar valley.

18th and 19th.—Accompanied reconnoitring parties to Alachi and Karamna, with reference to impending operations in Bazar valley. The country in this neighbourhood being now surveyed, I asked to be permitted to return to Dakha *vid* Michni to take up the survey of the portions of the Hyder Khan and Shinilo routes still unsurveyed, intending, while passing through Loi Shilman, to fix the course of Kabul river between Shinilo ferry and Kam Dakha from the peaks above Loi Shilman to the north.

The Commissioner of Peshawar advised me to wait a fortnight or so, till the country was less disturbed, and till a party of fanatics who had lately arrived in the neighbourhood had gone off again. Employed leisure in inking up and making copies of maps.

On 16th February—I received a letter from Major Hastings, Deputy Commissioner of Peshawar, telling me to be at Michni with one company Native Infantry on 26th.

Visit to Tartara Peak, Great Trigonometrical Station 144.

To utilize the intervening days I obtained an escort of Afreedee levies from Captain Tucker, Political Officer at Jamrúd, and proceeded to Lashera to finish up survey of Rotas slopes and to improve the rough survey made during the rapid advance of 21st November.

19th.—Surveyed Sapri and neighbourhood as far as Panipal.

20th.—Went to Laka Sar (Tartara, Great Trigonometrical Station 144) and took as long a theodolite observation as possible there.

26th.—Was joined by Tahsildar Shah Pasand Khán, appointed by Commissioner of Peshawar to accompany me. He sent for the various Tarakzai and Alimzai chiefs interested in the Shinilo route. I took a theodolite observation on Michni Fort.

27th.—While arrangements were being made by the Tahsildar, I went with a small escort to Sahib Chena, surveying the route by that village to Gandao and Pandiali.

28th.—The Tarakzai chiefs of the neighbourhood had come in and fully agreed to my completing the survey of the Shinilo route. Some Alimzai chiefs had also come in; others interested had sent word to the effect that they had no objection to my going where I pleased, but that owing to the presence of a certain fanatical leader, with a following of his own in Haki Gandao, they did not like to leave their villages, considering it better to remain as a check against this party of fanatics, to prevent their attacking me. At the same time they advised me not to halt the night at Zankhai on the Shinilo route, as that village was in a very indefensible position, and mischief might be done by any ill-disposed person. Accordingly it was arranged that on this day I should only survey up to Zankhai, taking no baggage with me, and returning at night to Michni. Next day I was to proceed to Hyder Khan and thence to Shilman, the Tarakzai chiefs undertaking to hold the Sapparai village, thereby to prevent any attack on my baggage. I had a full company of sepoys as escort; but as my trip would probably extend over ten days, it was advisable to work them as little as possible unnecessarily, so that the greater number would always be fit for night work, and more ready to repel any night attack; an attack in daylight being considered very unlikely.

Further, I had been along the Zankhai route before without any escort, and now was to be accompanied by a strong party of Tarakzais. A second party of these had also taken up a position on the heights above Zankhai to prevent possibility of surprise. The chiefs in fact thought it quite unnecessary to take any military escort on this short trip, especially as I had no baggage with me. However, I decided on taking 20 men with me, warning the remainder of the company for stiff climbing next day; and as there would be little climbing this day, I took mostly Sikh sepoys with me, reserving the Pathans for the next three or four days' rough climbing that I expected.

Starting early I reached Zankhai without alarm, and climbed to a neighbouring peak overlooking Gandao, from which I obtained an extended view northwards and westwards; while at work here the Tarakzai Khan with me drew my attention to a strong party of men in the valley far below, coming our way; so I determined to get back as soon as possible, and

began my descent. On neighbouring knolls were sitting two small armed parties, said to be grazing flocks, with whom I had entered into conversation, asking names of villages, &c. As I got well under them, these opened fire on my party, but thinking them shepherds I did not return the fire, and it soon ceased; on returning to the road all was quite. The chiefs now asked my plans for next day. On being told I intended going to Hyder Khan, they proposed to go and hold Sapparai for the night. The Tahsildar agreeing with the proposition, I let them go and did not see them again all day. The rest of my party, among whom were four influential Alunzais—one a Syud and two Akhoondzadas—with a small following, now started leisurely back; I surveying as we went.

We had gone about a mile when we suddenly discovered that the hill tops ahead were covered with armed men, apparently hurrying on to intercept my return to Michni, and shortly after, about 1 P.M., they opened a sharp fire on us. Without returning it I marched on towards Michni, hoping still to avoid a fight, but by 2 was hemmed in and obliged to return their fire. I started a man on a pony for reinforcements. Unfortunately the messenger fell from his horse and went limping on, not reaching Michni till 4. From 2 to 4 my sepoys skirmished from knoll to knoll and bush to bush, and owing to their steadiness and coolness kept the enemy back. Unfortunately we could find no good position to hold, and behind us was a steep rough descent. While crawling down this, the enemy twice charged into us with swords, and each time killed one man, themselves also losing men, and being driven back by the fire of the sepoys. A third sepoy was shot through the foot; a fourth fell with sunstroke, and had to be carried in the whole way. One sepoy, Sroop Singh, received three slight flesh wounds and had his belt cut in eight places, saving himself only by his determined courage. For the last few miles through the hills the enemy did not follow us up, and we got back without further loss to Michni.

1st March.—Having been joined by Major Hastings we went out again and brought in the corpses of the sepoys killed yesterday. I returned to Jamrúd on 4th March, and seeing no chance of doing any more surveying in this neighbourhood, I started to join Major Tanner at Jelalabad, where I arrived on the 12th.

Trip to Sikarám or Sikarram Peak.

26th May.—Started with a Kogiani escort to look up the eastern sources of the Surkhab river. Went through Kudikhel up along a pathway leading over the hills from Gundamuk to Harriob, known as the Gamchelar. Halted for the night above Jokan, a Ghilzai village, and continued the survey next day, halting the second night in a cave in the Jokandunah. We crossed a ridge the third day, and went down into the Kudikhel valley. Starting at daylight next morning, the 29th, we pushed up to the highest point of Sikarram or Said Karram-baba-ka Ziarat (Sikarám, Great Trigonometrical Station 171); height 15,620.

From 11,000 feet to 14,000 feet was one constant ascent over frozen snow, in which we had to cut steps. On reaching the elevation of 14,000 feet we came to about a mile of almost level snow—Sikarram Peak still ahead and on our right; slightly less elevated are the peaks which hem in and form the small lake (about 300 yards square) called *Haola khas*, and which is the source of the eastern feeder of the Surkhab river, known as the Mangul darrah. After crossing the level snow we had to cut steps up another steep for over 1,000 feet, and then passing the Ziarat had an easy ascent to the summit, about 50 yards further. The top was very steep on three sides, but the snow gave room to walk round the theodolite, which I fixed on some rocks that jutted out on the extreme summit. From this point I saw five camps of General Roberts' force, took observations to the fort at Peiwar Kotal and to a picket tent in Alikhel. I also observed several peaks across (south of) the Kuram valley, a snow peak in the ranges west of the Kabul valley, and a high prominent peak away many miles to the north, standing like a pyramid far above the heads of all surrounding peaks of the Hindu Kush. This was not visible from an elevation of 12,000, and I fear its position can now only be fixed by an observation from the peak overlooking the Shutr Gardan, or from some peak of Sufed Koh between Bassawal and Kuram. A good view was obtained of the large valley coming towards Alikhel from Ghazni. Unfortunately I could not, from the point of observation, see the camp at Gundamuk and stations there.

On 30th—I surveyed along the Agzan Lai, a pathway running across the hills from Murkekhel to Harriob over the Jamait Gakkho, much used, and took a theodolite observation at Aogai, returning on 31st to camp.

Agam valley.

The only valleys eastward from Gundamuk that had hitherto not been surveyed or reconnoitred were the Agam and Kambo. It was arranged that I should survey these now, on my way to Jelalabad, as the troops had been ordered back to India. Accordingly I started with an escort of 60 Lancers under Major Boyle through these valleys, and surveyed them between the 3rd and 6th, returning *vid* Dowlatzni to Jelalabad. The people in the villages *en route* seemed inclined to be sullen till they heard that we had the Ameer's Agent by the Ameer's order with us; then all hostility ceased, and they became very cordial.

Report on the operations connected with the Survey of country round and beyond Gilgit by LIEUT.-COLONEL H. C. B. TANNER, S.C., *Deputy Superintendent, 3rd grade, dated 10th January* 1880.

AFTER my return from Afghanistan it was determined to send a party to complete the Gilgit portion of the Cashmir survey, and I therefore started from Murree with two surveyors, Imam Buksh Bozdar and Ahmed Ali Khan, and a complete instrumental equipment. These

surveyors had both been employed in the Afghanistan survey operations, the one in the Kandahar and Girishk neighbourhood, and the other under me, with the Khyber column. They were both able men, fit to stand hard work and willing to carry their explorations with me into the little known territories to the west and north of Gilgit, where I had received instructions to proceed should opportunity offer. We arrived at Gilgit on 30th August and commenced field work about a week later, and relinquished operations on the 30th October.

2. The work performed embraces an area of some 1,800 square miles on the scale of 4 miles = 1 inch, besides a margin of 800 square miles of vague sketchy reconnaissance.

Extent and area of survey.

3. The tract mapped extends from Bunji on the Indus to Hopar ("the hole") on the Yasin and Ponyal frontier, a direct distance of 68 miles. Besides this, the Hunza river has also been surveyed from its junction with the Gilgit (or Yasin) river, a distance of 35 miles, to Bar, situated in the debatable lands which nominally belong to Cashmir, but the people of which are really independent and acknowledge only the chieftainship of one Ashur Khan, Raja of Chaprot, son of the chief of Nagyr (Nágar).

The Bagrot and Naltar valleys have also been surveyed, and some minor lateral streams, but those that rise in the great watershed between the Gilgit territory (Cashmir) and Tangir and Darail (Darel) still remain unexplored.

4. This great ridge, which has an average height of from 16,000 to 1,900 feet, and which extends from the very banks of the Indus at Bunji in the east—where it is abruptly cut off into enormous precipices, to the Kunar river in the west—is most difficult to map. The central backbone may be described as a huge broken table-land running up into wave-like ridges, which rise but a few hundred feet above the general level of the range. The ridges and peaks on the central backbone are all of nearly the same height, and are very similar to each other in appearance, and consequently not easy to identify from points more than a few miles apart. For this reason neither my surveyors nor myself have been able to fix with accuracy any points on the watershed, nor the passes which lead over the range, though several have been determined approximately. It is not I only who have experienced a difficulty here, for the Great Trigonometrical surveyors, when prosecuting the Cashmir triangulation, though they have fixed peaks far away even in the very heart of Kafristan, have failed to determine more than two or three points on the entire watershed, a distance of nearly 150 miles.

Ridge dividing Gilgit from Darel and Tangai.

5. From the beginning of September the great ocean-like expanse of wavy ridges was snowed up, and points over 14,000 feet were most difficult of access, so we were unable to visit any except the lower and northern spurs, which form the southern slopes of the Gilgit and Ponyal valley. We succeeded, however, in fixing (4) four Trigonometrical stations on the northern spurs of this range, and had the weather been ordinarily fine I might have done a large amount of geographical sketching to the westward, but except on one occasion I never had a clear day when on a mountain top, and in this respect I was most unfortunate throughout my operations. With great fatigue and labour I was able to fix a station on the peak to the west of the frontier fort of Gákuch, which is the extreme limit of the territory under the direct influence of the Maharaja of Cashmir, and which is situated in the neutral ground between Tangir and Yasin, and with clear weather I believe I should have been able to observe to Tirach Mir ("cattle-grazing hill"), Major Biddulph's great mountain near the Dorah Pass,* but snow came down shortly after my arrival on the peak, and I could see nothing but the lower portions of innumerable glaciers, which were sometimes revealed by the shifting curtain of cloud. This point† is the most northerly station of observation connected with the Great Trigonometrical Survey of India, and from it I hope some day to be so fortunate as to make great additions to our knowledge of the extensive unknown regions to the north, west, and south-west.

* This mountain was first brought to notice by Mr. (now Sir) R. Davis in his "Trade Resources, North-West Frontier," 1862.

† ("Shai Chish," "White Mountain.")

6. Altogether we have observed at eight new Trigonometrical stations,‡ several of which are fairly situated for observing to the north and west, but only one of them commands the ridge to the south, described in the 4th paragraph. In order to survey the features in this tract points on the watershed must be visited, and I understand that there will be no political difficulty in the way. Should I go back to Gilgit, the first work I should take in hand would be a station somewhere at the head of the Kergah§ nulla, which ought to command a very extensive view of the Darail country. The next in importance would be a station at the head of the Singal stream, which has not yet been explored, and which should give a view of one of the chief feeders of the Darail valley. It is by the Singal route that horsemen go from Gilgit to Manikial, in Darail, people on foot going by the Kergah valley. Another important station would be at the head of the Sai valley, which would command the Kinar stream.‖ The inhabitants of Sai are only half-hearted in their allegiance to the Maharaja of Cashmir, and those of Chilas positively unfriendly, and considerable caution would therefore have to be exercised in going to the head

‡ 6-inch or 5-inch theodolites were used.

§ "Gah" or "Bar" in the Gilgit (Shin) language means "valley" or "stream."

‖ The Kinar valley is not named on the Mulla's map. It joins the Indus opposite to Chilas.

of the Sai valley.* I have approximately fixed the easy grassy pass at that point, and it nearly agrees with that shown on the Mulla's map, but my approximate fixing of the passes leading to Manikial in Darail do not agree with the Mulla's quite so well. I met the Malik of Manikial, an old man, who in his day has seen a deal of fighting with the Cashmir troops, and he said he would be very glad to see me at his fort. At present only one European has been into Darail, and he had to go in disguise, but that was years ago, since which, partly owing to Major Biddulph's residence at Gilgit, the country has much quieted down.

* The inhabitants of Gilgit, Pongal, Darail, Tangir, Hunza, Nazyr, and Chilas are mostly Shins, and talk the Shin dialect. The Shins have altogether some 24 villages, and may number some 12,000 souls.

7. As to the future operations of a surveyor, who might have to fill in the topography of the country round Chilas, undoubtedly the best plan would be to fix stations on the Astor and Indus watershed, one north and the other south of Nange Parbat.† I hear that there are at least two points thereabouts, whence Chilas, the Indus valley, and the country beyond can be seen, and as they lie near the Srinugger and Gilgit road, they could be selected without much expenditure of time.

† Known to the people as "Deo Mir," the "Mountain of the Gods."

8. At the frontier of Hunza and Chaprot I endeavoured to fix a triangulation station, but after waiting in vain for four days for the clouds to clear off, had to start for another place. I left the Bozdar there, and he surveyed as far as Bar in the Garamsir valley, and he succeeded in fixing a number of villages between Chaprot and Hunza. This tract, and indeed all the mountain region about Gilgit except the range to the south of that place, is easy to survey, the peaks and valleys being so well defined. The labour of surveying, however, is exceedingly heavy, owing to the excessive amount of hill climbing that has to be gone through. It should be remembered that the altitudes of the mountain tops above the valleys is greater than in any part of the world, and in some deep valleys it is almost impossible to fix one's position on the plane-table.

9. The system of survey followed is nearly the same as that adopted by me in the Jelalabad valley. In the latter case I used rectangular co-ordinates measured from the centre of each degree, but that system has its disadvantages, and now spherical co-ordinates are used instead. Angles are taken‡ to points previously fixed by the Great Trigonometrical Survey, then by means of the spherical co-ordinates (latitudes and longitudes) of these points, the distances between them, and the azimuthal directions of one from the other, are computed, and the case is treated as in common interpolation.

System of survey.

‡ 6-inch and 5-inch theodolites were used.

10. The height of the chief places in the valley have been determined by the Aneroid and Marriotti's pocket mercurial barometer. At nearly 15,000 feet the latter instrument gave a height only differing from the true height by 28 feet; at Gilgit, 4,800 feet, its reading corresponded within 0·1 of an inch with Dr. Scully's standard barometer. At Mussooree within 0·1 of the standard. After a year's use I strongly recommend the instrument to the notice of travellers. It is very portable, not very liable to break, and a series of observations may be taken with it within ten minutes. I find that accuracy is more readily attained if, previous to taking a reading, the mercury be screwed up and down several times in the tube. This seems to have the effect of cleaning out the tube, as it were, and of equalizing the temperature of the mercury of the compressed air in the bulb and of the different parts of the instrument. Some heights have been determined trigonometrically, but as the horizontal angles were of greater importance than heights, and as the peaks except in one instance were clouded over during the observations, I have few vertical angles.

Heights.

11. Throughout the operations of my small party I have received every help and assistance from Major Biddulph and Dr. Scully of Gilgit. Nor must I omit to mention the attention I have received from Ram Kishen, the Native Governor of Gilgit, nor the aid and co-operation of the Rajahs of Ponyal and Chaprot. The latter were perhaps *too* careful of me, and tried constantly to impress on me the danger I ran in surveying without a strong escort both at the frontier of Yasin and of Hunza. It was at Gakuch, on the Yasin frontier, that I received an order from Government not to cross the frontier line, and I reluctantly turned back from the highly interesting and little known country to the west, as I had done a few months previously from the capital of the Chugani country in the mountain region to the north of Jelalabad; and though in both these expeditions the attempts made to reach the heart of the mysterious land to the south of the Hindu Kush has failed, yet neither of them have been altogether without results, and I have to some extent added to the accurate geographical knowledge which is gradually encroaching on the ever decreasing area of the *terra incognita* which surrounds Kafristan.

Extract from the Narrative Report, dated 2nd November 1879, *of* CAPTAIN A. W. BAIRD, R.E., *in charge, Tidal and Leveling Operations.*

EVALUATION OF TIDAL CONSTANTS AT BOMBAY.

From the observations for 1878.

Short-period Tides.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ.	ν.	μ.	MS.	2SM.
R_1 ...	·0753	·05414	1·5040	·73333	·4039	·0491	·1389	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	186°·710	312°·010	130°·117	324°·417	312°·309	171°·172	323°·790	.....	.....	.....	.....	.....	.....	.....
R_2 ...	1·614	3·86593	·5063	.....	.....	.....	.....	·0655	·0968	·0496	·2797	·2193	.....	·0381
ϵ_2 ...	2°·535	328°·586	336°·705	.....	.....	.....	.....	125°·170	310°·427	103°·704	317°·867	309°·959	.....	92°·643
R_3 ...	.....	·07080	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	29°·817	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	·0176	·11269	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	·1191	.....
ϵ_4 ...	256°·517	316°·647	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15°·191	.....
R_6 ...	·0029	·01316	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	194°·744	124°·995	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8 ...	·0015	·00336	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ...	86°·186	309°·898	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

		Feet.	
Lunar monthly tide	...	... R = ·053	ϵ = 314°·523
„ fortnightly tide	...	... R = ·091	ϵ = 331°·726
Lunisolar ditto	...	... R = ·055	ϵ = 199°·182
Solar annual tide	...	... R = ·254	ϵ = 116°·571
„ semi-annual tide	...	... R = ·068	ϵ = 304°·354

The analysis of these observations give results which differ but slightly in the main quasi-tides from those obtained by the reduction of the 1876 observations.

The value of (Ao) mean level of sea differs by ·12 feet from that obtained in 1876, being 80·265 instead of 80·141 feet above Town Hall datum.

The value of the amplitude of the main lunar tide (R_2 of M) is 3·89 feet from these observations, against 3·93 feet obtained in 1876, *i.e.* the amplitude is about ½ an inch greater, while the value of the solar semi-diurnal (R_2 of S) is almost precisely the same as was obtained in 1876.

The proportion between the lunar elliptic semi-diurnal (L) and the main tide is by these observations ·017, against ·05 from the 1876 observations; but the larger lunar elliptic semi-diurnal tide (N) agrees well with what was obtained in 1876, being about 25 per cent. of the main lunar tide. The evection and variation quasi-tides λ, ν, μ, are fairly concordant in value with what was obtained in 1876, as are also the lunisolar declinational and the lunisolar compound semi-diurnal tide (2SM).

The whole of the diurnal tides agree well with what was found in the 1876 observations, except (R_1 of J) the lunar elliptic tide, which is only about ⅓rd of its value in 1876, and (R_1 of M) the lunar diurnal, which is only ⅓ its value as determined by the 1876 observations.

The proportion of the solar declinational tide P to the lunar declinational O is about 1 to 1·81, while in 1876 it was about 1 to 1·87. Theory would give the proportion as varying between 1·74 and 2·56.

The proportion between the two lunar elliptic tides (J and Q) is 1 to 2·8, while in 1876 observations it was found to be 1 to 1·2 theory, giving the proportion to be about 1 to 2·4.

The overtides of S are quite insignificant, except perhaps the quarter diurnal, which is about 1 per cent. of the main solar tide. This agrees well with the 1876 value. The overtides of M are almost precisely the same in value from these observations as was found in 1876 observations. The proportion between the lunar terdiurnal tide and lunar semi-diurnal is ·018, which agrees precisely with what was formerly found.

The quarter diurnal lunisolar tide MS bears precisely the same proportion to the combined lunar and solar semi-diurnal tides as it did in the 1876 reduction, viz. ·022.

EVALUATION OF TIDAL CONSTANTS AT KURRACHEE.

From the observations for 1874-75.

Short-period Tides.

		S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*MS.*	*2SM.*
R_1	...	·0764	·1187	1·4266	·7658	·3858	·1008	·1438	.....	.....	.....	.....	.....	.....	.....
ϵ_1	...	162°·496	143°·241	139°·043	311°·790	315°·978	129°·818	324°·599	.....	.....	.....	.....	.....	.....	.....
R_2	...	·8491	2·4342	·3172	.....	.....	.....	.....	·0618	·5418	·0206	·0221	·0519	.....	·0170
ϵ_2	...	319°·932	292°·794	332°·332	.....	.....	.....	.....	122°·449	277°·384	8°·100	320°·990	275°·887	.....	148°·811
R_3	...	.....	·0251	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	...	.....	337°·311	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4	...	·0081	·0188	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	·0203	.....
ϵ_4	...	6°·419	9°·412	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	304°·671	.....
R_6	...	·0069	·0510	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6	...	308°·530	214°·443	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8	...	·0026	·0048	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8	...	265°·601	199°·869	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

			Feet.	
Lunar monthly tide	...	...	$R = 0·057$	$\epsilon = 23°·655$
,, fortnightly tide	...	...	$R = 0·054$	$\epsilon = 49°·183$
Lunisolar fortnightly tide	...	...	$R = 0·039$	$\epsilon = 332°·296$
Solar annual tide	...	...	$R = 0·149$	$\epsilon = 56°·270$
,, semi-annual tide	...	...	$R = 0·172$	$\epsilon = 156°·647$

The values of the amplitudes and epochs computed for 1874-75 call for no special mention. R_1 of M is nearly double of its average value in the previous years which have been reduced, but R_3 of M is only about $\frac{1}{3}$ its former value.

R_1 of K = 1·426, against 1·250, its average value in the previously computed observations.

Series 2SM has been computed for the first time, and gives values $R_2 = 0·017$ and $E_2 = 148°·881$.

The long period tide constituents deduced are very much similar in value to those deduced in the former years.

EVALUATION OF TIDAL CONSTANTS AT KÁRWÁR.

From one year's observations commencing on the 1st March 1878.

Short period Tides.

		S.	*M.*	*K.*	*O.*	*P*	*J.*	*Q.*	*L.*	*N*	λ.	*ν.*	*μ.*	*MS.*	*2SM.*
E_1	...	·0673	·0421	1·0851	·5620	·2693	·0519	·1257	.....	.....	.....	.....	.....	.....	.....
ϵ_1	...	158°·705	332°·241	136°·594	326°·537	311°·402	132°·940	333°·922	.....	.....	.....	.....	.....	.....	.....
R_2	...	·6312	1·6819	·2130	.....	.....	.....	.....	·0562	·4059	·0214	·0753	·0313	.....	·0118
ϵ_2	...	335°·485	301°·604	317°·065	.....	.....	.....	.....	157°·623	279°·996	61°·984	338°·158	280°·069	.....	32°·359
R_3	...	.....	·0116	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	...	.....	277°·446	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4	...	·0067	·0527	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	·0208	.....
ϵ_4	...	114°·656	24°·988	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	78°·757	.....
R_6	...	·0015	·0120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6	...	51°·608	283°·698	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8	...	·0018	·0010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8	...	343°·010	202°·657	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides at Kárwár.

			Feet.	
Lunar monthly tide	...	...	$R =$ ·042	$\epsilon = 350°{\cdot}582$
„ fortnightly tide	...	...	$R =$ ·067	$\epsilon = 329°{\cdot}902$
Lunisolar fortnightly tide	...	...	$R =$ ·028	$\epsilon = 215°{\cdot}501$
Solar annual tide	...	...	$R =$ ·170	$\epsilon = 321°{\cdot}951$
„ semi-annual tide	...	...	$R =$ ·045	$\epsilon = 296°{\cdot}816$

The proportion between the two chief tides (solar and lunar semi-diurnal) at Kárwár is 1 to 2·7, which is larger than the equilibrium theoretical proportion (1 to 2·1), but agrees fairly well with the proportion found at Karachi, but is not so close to the equilibrium theoretical proportion as at Bombay or Aden.

The proportions between the lunar elliptic semi-diurnal tides and the main tide are each a little larger than the equilibrium theoretical value would give; the smaller component L being ·033 of the main tide (R_2 of M), against ·027 the equilibrium theoretical value; and the larger component N at Kárwár being 0·241 of the main tide, against ·192 its equilibrium theoretical value.

The two evectional semi-diurnal tides agree well with what theory would assign, the proportions to the main tide being ·012 for λ and ·045 for ν, while the equilibrium theory would show the proportions to be ·007 for λ and ·037 for ν; thus each of these quasi-tides at Kárwár would appear to be a little larger than theory would give.

The variation semi-diurnal tide μ, on the other hand, is a little smaller at Kárwár than the equilibrium theoretical proportion, *viz.* ·018, against ·022.

The semi-diurnal component of the lunisolar declinational tide (R_2 of K) deduced from these observations agrees precisely in its proportion to the main lunar tide with the equilibrium theoretical value, *i.e.* the proportion is ·127 to 1·0. At Karachi it was found that this tide on the average gave a less value than theory would assign to it, while at Bombay it is a little larger, and at Aden a good deal larger, than the equilibrium theoretical value.

The proportion of the lunisolar compound semi-diurnal tide to the main tide is very small, ·007 at Kárwár, which agrees well with what has been found at Bombay and Karachi, but is less than half the comparative value which was found to obtain at Aden.

Of the diurnal tide at Kárwár, the chief one, R_1 of K, bears a proportion to the main lunar tide of ·645 to 1·0, which is nearly double what was found at Bombay, and 20 per cent. greater than the proportion at Karachi, but still is only about $\frac{3}{5}$rds of the comparative value of the same quasi-tide at Aden, where it almost equalled the main tide, thus causing the tides at the moon's quarters to be practically only one High-Water and one Low-Water in the 24 hours. This peculiarity obtains to a limited extent at Kárwár; the diurnal inequality must, on account of the large value of R_1 of K, be very great.

R_1 of S, *i.e.* the solar diurnal tide, is about $\frac{1}{10}$th of the principal component of this quasi-tide, a proportion found to obtain at Aden, while at Bombay and Karachi the proportion was $\frac{1}{17}$th and $\frac{1}{23}$th respectively.

This tide being probably due to temperature, should be practically of equal values for the same latitude.

The solar diurnal declinational tide, R_1 of P, has at Kárwár a proportion of ·16 of the main lunar tide, which agrees almost exactly with what has always been found at Karachi, but is 50 per cent. greater than the proportion at Bombay

The diurnal component of the lunar tide (R_1 of M) is about $2\frac{1}{2}$ per cent. of the semi-diurnal component, which agrees fairly well with what obtains at other places.

The lunar diurnal declinational R_1 of O is larger in its proportion to the main tide at Kárwár than was found at Karachi and Bombay, but a good deal less than that at Aden.

Of the lunar elliptic diurnal components R_1 of J and R_1 of Q, the first agrees fairly well with what was found at Bombay and Karachi, but is less than half of the proportion at Aden, while the latter component is about 50 per cent. greater than at Bombay and Karachi. But indeed at Aden, as will be seen from the remarks on the reduction of the observations at that port, all the diurnal tides are larger in proportion than at any port where observations have as yet been taken.

The proportion of the overtides of the solar tide S (R_4 R_6 R_8) to the main component of that tide (R_2 of S) are ·011, ·003, ·003, which accord well with what obtains at Bombay and Karachi, while at Aden the values for the two last quasi-tides are much larger; thus, the quarter diurnal solar overtide at Kárwár is about 1 per cent. of the main component, while the other overtides are barely appreciable.

The proportions of the lunar overtides R_4 R_6 and R_4 of M are ·026, ·007, ·001, proportions agreeing well with what was found at Bombay, but not with what was obtained at Karachi, while at Aden all three overtides came out extremely small.

The terdiurnal component of M is only ·007 of the main component, which is less than half what obtains at Karachi and Bombay.

The lunar monthly has an amplitude of $2\frac{1}{2}$ per cent. of that of the main lunar tide, which agrees fairly well with what was found at Karachi and Aden.

The lunar fortnightly is in proportion to the main lunar tide, ·04—a value concordant with what was found at Aden, but double what the proportion was found to be at Karachi and Bombay.

The lunisolar fortnightly tide at Kárwár agrees fairly well with the value at Karachi and Aden, and is double of the value at Bombay when taken in proportion to the main lunar tide.

The solar annual tide is $\frac{1}{70}$th of the main lunar tide, while at Karachi the proportion was about $\frac{1}{78}$th, and at Bombay only $\frac{1}{210}$th; but at Aden this tide is extremely large, being actually $\frac{1}{4}$th of the main tide.

The semi-annual tide is smaller in proportion than the value obtained at Bombay and Karachi, and is only about $\frac{1}{6}$th of the proportional value which was found at Aden.

EVALUATION OF TIDAL CONSTANTS AT ADEN.

From the observations of 1877-78, by old small scale tide-gauge.

Short-period Tides.

		S.	*M.*	*O.*	*K.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*MS.*	2 *SM.*
R_1	...	0·069	0·091	0·706	1·325	0·349	0·103	0·170	.....	.....	.....	.....	.....	.....	.....
ϵ_1	...	162°·278	348°·216	310°·898	119°·430	301°·345	125°·767	308°·303	.....	.....	.....	.....	.....	.....	.....
R_2	...	0·658	1·415	.....	0·223	.....	.....	.....	0·033	0·420	0·028	0·083	0·079	.....	0·024
ϵ_2	...	245°·055	223°·192	.....	224°·295	.....	.....	.....	14°·224	215°·561	253°·945	270°·373	215°·651	.....	29°·758
R_3	...	.....	0·015	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	...	.....	221°·769	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4	...	0·009	0·007	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·014	.....
ϵ_4	...	278°·403	290°·809	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	208°·139	.....
R_6	...	0·006	0·004	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6	...	228°·289	327°·230	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8	...	0·004	0·002	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8	...	299°·931	147°·028	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

Lunar monthly tide (σ—ω)	R =	0·025 feet.
	ϵ =	320°·759
„ fortnightly tide (2 σ)	R =	0·062 feet.
	ϵ =	2°·798
Lunisolar fortnighly tide (σ—η)	R =	0·020 feet.
	ϵ =	341°·528
Solar annual tide (η)	R =	0·347 feet.
	ϵ =	0°·090
„ semi-annual tide (2 η)	R =	0·211 feet.
	ϵ =	118°·050

The values for R and T were not computed, as two years' consecutive work is required to obtain their amplitudes and epochs.

The proportion between the two chief tides (solar and lunar semi-diurnal) is as nearly as possible 1 to 2·1, which is the equilibrium theoretical proportion. This is the nearest approach to the theoretical value yet obtained in the reductions of any year's observations of any place.

The solar diurnal tide R_1 of S is about $\frac{1}{16}$th of the semi-diurnal component, while at Bombay it is about $\frac{1}{14}$th, at Karachi $\frac{1}{13}$th, and in the Gulf of Cutch $\frac{1}{10}$th. This probably being due to temperature, should be practically of equal values for same latitude.

The quarter diurnal (R_4) of S is about $\frac{1}{7}$rd of the main component (R_2), which is very similar to Bombay and Karachi; but the other overtides of S, viz. R_3 and R_5, are nearly three times as large in comparison to the main tide as at Bombay. R_4 and the other overtides being due to tidal friction, will vary according to local circumstances.

The proportion of the smaller of the lunar elliptic semi-diurnal tides (L) to the chief lunar tide (R_2 of M) is as nearly as possible equal to the theoretical value, while the proportion of the larger component (N) to the main lunar tide is about 50 per cent. greater than it should be by theory, while at Bombay and Karachi it is only about 25 per cent. greater. The value of L is generally small, and not always reliable. The value of N is generally pretty regular; the result for Aden is certainly large.

The proportion of the semi-diurnal tide (λ) is at Aden about three times as great as it ought to be by theory, which is similar to what was found at Karachi, while at Bombay this tide was found to agree with the theoretical value.

The larger evectional semi-diurnal component (ν) is about 60 per cent. greater than theory would assign to it, which also was found to be the case at Karachi, while at Bombay this tide was found to have only about $\frac{1}{4}$th its equilibrium theoretical value. But much weight cannot be given to the results of these small tides for places with comparatively small tide range.

The variational semi-diurnal tide (μ), on the other hand, agreed with the proportion to the theoretical value which obtained at Bombay, that is, about $2\frac{1}{2}$ times greater than the theoretical value, while at Karachi the theoretical proportion was found to obtain. The results obtained for μ at other places are generally good.

The semi-diurnal component of the lunisolar declinational tide (R_3 of K) is a little greater than the theoretical proportion, as was found to be the case at Bombay, while at Karachi the proportion was about 25 per cent. smaller than it should be.

But the distinctive feature in the Aden tides is the very large value obtained for all the diurnal tides, each one of which is about double (in comparison to the main lunar tide) the value obtained at Karachi and Bombay.

The proportions of the solar diurnal declinational tide to the lunar diurnal tide agrees fairly well with theory; but the proportion between the lunisolar diurnal declinational and the lunar diurnal declinational tide is about 2 to 1, which agrees well with what was found at Karachi and Bombay; but it is about 25 per cent. greater than what theory assigns.

The value of R_1 of K is practically the same as R_2 of M, which has the effect of giving only one High-Water and one Low-Water at the times of the moon's quarters—a feature at once apparent in looking at the diagrams.

With regard to the Long-Period Tides, the amplitude of the lunar monthly is very nearly 2 per cent. of that of the main semi-diurnal tide (R_2 of M); this is nearly the same value as was found at Karachi and the Gulf of Cutch, and is three times as great as was found at Bombay from the 1876 observations.

The lunar fortnightly is nearly $4\frac{1}{2}$ per cent. of the lunar semi-diurnal, which is more than double the magnitude (as measured in comparison with the lunar semi-diurnal) which was found to obtain at Bombay, Karachi, and the Gulf of Cutch. This tide would appear to be hardly appreciable in England from the reductions of the observations hitherto made; but at Bombay, Karachi, and two stations on the Gulf of Cutch, the proportion is nearly the same for all, viz. two per cent., while at Aden, as above stated, it is nearly $4\frac{1}{2}$ per cent.

The lunisolar fortnightly has a value, as obtained from these observations at Aden, of $\frac{14}{1000}$ths of the main semi-diurnal tide, which agrees well with what was found at Karachi, but is double what was found at Bombay, and only half of the value obtained in the Gulf of Cutch.

The prominent feature in the Long-Period Tides at Aden, as deduced from these observations, is the comparatively large magnitude of the solar annual and semi-annual tides. The solar annual is nearly $\frac{1}{4}$th, and the semi-annual over $\frac{1}{7}$th, of the size of the main semi-diurnal tide. These proportions are very large indeed as compared with Bombay, Karachi, and the Gulf of Cutch. At Tuticorin, it is true, the solar annual was found to be proportionately even larger than at Aden; but its maximum there occurring about the middle of the north-east monsoon, it was surmised this tide might be almost entirely due to wind.

The epoch of the solar annual tide at Aden would show that it attained its maximum on the 21st March, which would preclude the idea of a larger portion of its value being due to the south-west monsoon, as might at first be supposed.

The time of maximum of the solar semi-annual, as deduced from the observations, is about 18th May and 17th November.

It is another peculiarity of the solar annual tide at Aden that, as far as these observations show, it attains its maximum on the day of the vernal equinox, which is the time from which its epoch is reckoned.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR, GENERAL'S OFFICE.

Statement showing the nature of the work performed, and the progress made, from 1st October 1878 to 30th September 1879.

MAPS.	SCALE. Inch. Mile.	REMARKS AND PROGRESS.
India, 6 sheets. Outline and names. Engraving.	1 = 32	Sheets I, II, and IV. Fresh additions and a few revisions made to date, and hills drawn on dry prints of Sheets I and II for engraving or lithography. Sheet III. Fresh additions made from recent surveys, to date. Hills not yet taken up. Sheet IV. Hills drawn on a dry print proof. Well advanced. In progress. Sheet V. Fresh additions and a few revisions made to date. Hills not yet taken up. Sheet VI. Compilation and drawing of sheet completed in outline with names. Hills not yet taken up.
India, No. 3—4 sheets. Outline and names. Engraving.	1 = 64	Sheets I, II, III, and IV. Fresh additions and revisions made to date on dry print proofs for insertion on the copper-plates.
Ditto ditto. Lithographic Press transfers.	1 = 64	Sheets $\frac{\text{I and III}}{\text{in one}}$ and $\frac{\text{II and IV}}{\text{in one}}$. Press proofs. Dry prints completed and revised to date for a new edition. Hills re-drawn in brush for engraving or lithography.
India, No. 2. Outline	1 = 128	Revisions and additions made to date for a new edition, and a copy prepared in colours for press to show progress of the Imperial Surveys up to 1877-78. For Departmental Report.
Bengal, 2 sheets. Outline and names. Engraving.	1 = 16	Revisions and additions made to date on dry prints. Hills not yet taken up.
Punjab, 4 sheets. Outline and names. To be engraved.	1 = 16	New compilation, embracing recent surveys to date. Drawing and compilation in outline of country within British limits. Sheets I and II well advanced, Sheets III and IV commenced. In progress.
Central Provinces, 2 sheets. Outline and names. Engraving.	1 = 16	Hill drawing on mounted silver prints of the original outline compilation. In progress.
Central India Agency, 2 sheets. Outline and names. Engraving.	1 = 16	Fresh additions made on dry prints from recent surveys to date, and hill drawing on mounted silver prints of the original outline compilations. In progress.
Rajputana Agency, 2 sheets. Outline and names. Engraving.	1 = 16	
Assam, 9 sheets, being lithographed.	1 = 8	Sheets II and III. Compilation and drawing of additions to date from recent explorations in the Mishmi hills, on proofs and originals, to complete.
Countries between Hindustan and Caspian Sea.	1 = 64	Revision of original and proof for a new edition.
Country round Kabul	1 = 1	Sheet I. Copied from a rough original, and drawn with hills, for reproduction.
Frontier sketches and surveys, from Jamrud to Gandamak, and of the Kuram and Khost valleys.	1 = 4	A general compilation made of the country from Jamrud to Gandamak and of the Kuram and Khost valleys, from sketches and surveys of officers of the Survey of India, attached to the Afghanistan expeditionary force.
The two routes to Kabul *vid* the Kuram and Khost valleys and the Khybar Pass.	.....	A general compilation made of the adjoining country beyond the above from various sources, with the hills in vertical style. The two compilations joined together and issued as a single map with the title named.
District Maps.		
Barcilly	1 = 8	Drawn for the *Gazetteer*, N.-W. Provinces.
Gorakhpur	1 = 8	
Bahraich	1 = 4	Extracted from the sheets of the Atlas of India, and prepared and completed to date for publication.
Dinagepore	1 = 4	
Gya	1 = 4	
Jalpaiguri	1 = 4	
Shahabad	1 = 4	
Balaghat. Outline and names ...	1 = 4	Compilation and drawing completed in outline from recent surveys.
Karnal. Outline and names ...		
Index Maps.		
Surveys of India	1 = 64	Additions *to* date made in Office Index.
Hyderabad Circars	1 = 32	Index to the sheets, drawn.
Godavari Taluks	1 = 32	Ditto ditto.
Afghanistan	1 = 48	Ditto of Major Wilson's map of Afghanistan, drawn for reduction to half scale.
Pendulum operations	1 = 128	An Index drawn on a *copy* of India, No. 2, to show the mean average heights for every degree in India.
Index to the sheets of the Atlas of India.	1 = 256	Showing engraving and publication to date for report of 1878-79. Proof revised.
Charts of triangulation. Khasi, Garo, and Naga Hills survey.	1 = 32	An Index to the charts prepared.

Sheets of the Atlas of India, 1 inch = 4 miles.

Sheet 8, N.E. } Parts of Sind, Dera Ghazi Khan,	Additions in outline of Bahawalpur, and revisions
,, S.E. } and Bahawalpur.	from recent surveys to date.
,, 12, S.W.* } Parts of Kattywar, Bombay	Drawn in outline to extent of survey.
,, S.E. } Presidency.	Additions on west, drawn in outline to complete.
,, 13, N.W.* } Parts of Kattywar, Bombay	Drawn in outline to extent of survey.
,, N.E. } Presidency.	Additions on west, drawn in outline to complete.
,, S.E.* }	Outline drawing in progress to extent of survey.
,, 19, N.E.* Parts of Jessulmere, Jodhpur, and Bickaneer.	Drawn in outline to extent of survey.
,, 18, S.W. Part of Bahawalpur ...	Additions on west, drawn in outline to complete.
,, 22, N.E. } Parts of Gujarat, Bombay Pre-	Additions drawn in outline to extent of survey.
,, S.E. } sidency.	
,, 23, N.W. } Parts of Gujarat and Kattywar,	A small portion on west, revised.
,, N.E. } Bombay Presidency.	Additions drawn in outline to extent of survey.
,, 32, S.W.* }	Drawn in outline to extent of survey.
,, N.W.* } Parts of Bickaneer, Shaikha-	Outline drawing in progress to extent of survey.
,, N.E. } wati, and Hissar.	Ditto ditto to complete.
,, S.E. }	Additions on west drawn in outline to complete.
,, 33, N.W. Parts of Jodhpur and Bicka- neer.	Ditto ditto ditto.
,, 35, S.W.* Parts of Oodeypur and Don- garpur.	Drawn in outline to extent of survey.
,, 36, S.W.* Parts of Rewakanta and Ali Rajpur.	Ditto ditto ditto.
,, N.E. Part of Malwa	Additions drawn in outline to extent of survey.
,, 37, N.E. } Parts of Rewakanta, Khandesh,	Additions on west, drawn in outline to complete.
,, N.W.* } Barwani, and Indore.	Drawn in outline to extent of survey.
,, 48, N.E. Parts of Bijnor, Dehra Dun, &c.	Drawing in outline in progress.
,, 53, S.W. Parts of Indore and Bhopal ...	Hills drawn complete with additional outline.
,, 65, F.P. Do. Garhwal and Hundes	Additions drawn complete with hills to extent of materials received.
,, 66, N.W. }	{ Hills drawn complete on a dry print of each, with
,, S.E. } Parts of Bijnor, Kumaun, and	{ additional outline.
,, N.E. } Garhwal.	{ Additional outline drawn to complete, and hill shad-
,, S.W. }	{ ing in progress.
,, 71, N.E. Parts of Jubbulpore and Mandla.	Additions on east drawn complete with hills.
,, 72, N.E. Parts of Bhandara, Seoni, and Balaghat.	Ditto ditto ditto.
,, 92, N.W. Parts of Raipur and Bastar ...	Hills drawn on a dry print complete.
,, 118, F.P. Parts of Jalpaiguri, Cooch Behar, Bhutan, and Sikkim.	Revision of south-east portion (district Goalpara) from recent survey, in progress.
,, 129, N.W.* }	Drawn in outline to extent of materials received.
,, } Parts of districts Lakhimpur	
,, N.E. } and Sibsagar, Assam, and	{ Additions drawn in outline to extent of materials
,, S.W. } Dafla and Miri Hills.	{ received.
,, S.E. }	
,, 130, N.E. Parts of Sibsagar and Naga Hills, Assam.	Hills drawn on a dry print complete.
,, 138, N.W.* } Parts of Lakhimpur and Sib-	Drawn in outline to extent of materials received.
,, S.W.* } sagar, Assam.	

* The 12 sheets marked * are new sheets.

Standard Sheets of the Topographical Survey re-drawn for re-production.

Ganjam and Orissa Survey.	Scale. In. Miles.	
Sheets 85 and 87 in one	1 = 2	Fair drawn, complete with hills.
,, 88, 89, 90 and 91 in one	1 = 2	Ditto, hills in progress.
,, 92, 93, 94, 95 and 95a in one	1 = 2	Ditto, complete with hills.
Mysore Survey.		
Sheets 34 and 57	1 = 1	Originals examined, corrected, touched up, and completed for publication.
Bhopal Survey.		
Sheets 22, 23, 25, and 41	1 = 1	Ditto ditto ditto.
Rajputana Survey.		
Sheet 12, half degree south ...	1 = 2	Ditto ditto ditto.
Central Provinces and Vizagapatam Agency Survey.		
Sheets 12, 13, and 14	1 = 1	Fair drawn, complete with hills, from the original field sheets.
,, 30 and 97 in one and 35 and 37 in one ...	1 = 2	

Standard Sheets of the Topographical Survey re-drawn for re-production—continued.

Hyderabad Topographical Survey (Godavari Taluks.)	Scale. In. Miles.	
Sheets 1 and 2	1 = 1	Fair drawn in outline from original field sections.
,, 3, 6, and 7	1 = 1	Drawing in progress in various stages.
Khasi, Garo, and Naga Hills Survey.		
Sheets 161, 162, 163, 164, 165, 168, 170, and 171.	1 = 2	Fair drawn, complete with hills, from the original field sheets.
Sheets 107 and 122...	1 = 1	Original sheets connected with the Revenue Survey sheets of Sibsagar.

Miscellaneous Maps, Tracings, &c.

Assam (photo-zincograph proofs)	1 = 16	Five copies prepared, shewing recent explorations in the Mishmi Hills, to illustrate Captain Woodthorpe's report of 1877-78. For Foreign Department.
Simla Survey, sheets 1 to 20 ...	24 = 1	Areas of the several estates entered on the sheets, for publication.
Hyderabad Circars	1 = 4	Twelve sheets of the Atlas of India, embracing the Circars or the Nizam's dominions, coloured, to show the Circar boundaries as at present known. For the Resident, Hyderabad.
Assam, River discharges	.....	Various drawings made to illustrate the report of the "Operations for obtaining the discharges of rivers in Assam."
Projections	1 = 2	Four sheets projected with points for Mr. Peel, Assam, with the extreme limits of topographical work of No. 6 party drawn thereon.
Kuram Valley Roads, various ...	.....	Thirty original sections connected at the junctions and arranged on vellum cloth for press guidance.
Map of Manipur, with part of the Kuboo Valley and Burmese Frontier.	.....	An extract taken from same and six silver print copies coloured and prepared for Foreign Department.
Northern Bengal, Trade Routes ...	1 = 16	Trade routes between Bengal and Behar, and Nepal, Sikkim, and Bhutan, prepared from various rough sketches for the Bengal Government.
Kumaun Sarda Islands	.....	Tracing made on vellum cloth for the Resident, Nepal, from an original supplied by him.
Katmandu, Nepal	.....	Tracing made on vellum cloth of native map of Katmandu, with the names written in English for press guidance.
Chart of Triangulation, Burmah Party, 1877-78.	.....	A copy made, with a synopsis of data for the Deputy Surveyor-General.
Eye sketch of roads from camp Daulatzai.	.....	Copy fair drawn with hills for re-production.
Pergunnahs, District Benares ...	.....	Extract of certain pergunnahs from the original sheets traced on vellum cloth for the North-Western Provinces Government.
Great Trigonometrical Data within the Nizam's Dominions.	.....	A list of data prepared for the Government of His Highness the Nizam.
Military stations, Bombay Presidency.	.....	A list showing the latitudes, longitudes, heights, and distances from the sea of the several military stations of the Bombay Presidency, prepared for the Sanitary Commissioner of Bombay.
Melghat Taluk, four sheets ...	1 = 1	The taluk divided into four sheets and tracing of same made on vellum cloth from the original sheets of the Hyderabad survey, completed with outer names, borders, &c., for the Deputy Commissioner, Ellichpur.
Chota Nagpore Topographical Survey.	.....	Numerical data of triangulation of season 1863-64, prepared for the Deputy Surveyor-General.
Average heights for every degree of India.	.....	Twenty-three heights below latitude 24°, and 71 heights above latitude 24° extracted.

Examination, corrections, and additions to original survey sheets, maps, &c.	89 original sheets examined, corrected, and touched up for re-production and engraving.
Examination, corrections, and additions to engraved, lithographed, and photo-zincographed proofs.	Blanks filled up, railways, boundaries, territorial names, headings, foot-notes, titles, &c., inserted in 53½ sheets.
Atlas Sheets and engraved maps coloured.	1,780 sheets.
Lithographed and photo-zincographed maps and plans coloured.	14,750 do.

Work done in the Examining Branch from 1st October 1878 to 30th September 1879.

Examination	of original standard sheets of Topographical surveys, standard sheets compiled in Surveyor-General's Office and other general compilation ...	43
Ditto	large scale maps of Simla, Subath, and Chitogarh	18
Ditto	original compilations of parts of Atlas sheets	24
Ditto	of engraved proofs in outline, names, &c., in various stages	58
Ditto	of engraved proofs of general maps, &c., including India	15
Ditto	of original triangulation charts	4
Ditto	photographed and lithographed proofs of all kinds and various scales ...	80
Projections	of graticule	40
Ditto	of trigonometrical points	68
Work compiled in Section II [Atlas sheet 67 S.E., 129 N.E. (portion), and parts of Turkistan map under Surveyor-General's directions]		3
Dr. Hunter's alphabetical list of latitudes and longitudes for the *Imperial Gazetteer* ...		From C. to Z.
Miscellaneous work	Supply of data to various officials. Computation of Atlas graticule. Calculation of co-ordinates. Reports and memoranda of current work, &c.	

(SD.) J. F. BANESS,
Surveyor and Chief Draftsman

(SD.) EDWARD H. STEEL, *Captain*,
Assistant Surveyor-General.

A.

Progress Report of the Engraving Branch from the 1st October 1878 to the 30th September 1879.

Title of Map.	Outline and writing.	General maps and compilations.
	Sq. in.	
Map of India in 6 sheets; scale 32 miles = 1 inch.	884—O.	Almost ready for first issue.
Map of India in 4 sheets; scale 64 miles = 1 inch.	403—S.C.	Outline to corrections and additions done; the writing will be taken up as soon as possible.
Map of Bengal in 2 sheets; scale 16 miles = 1 inch.	.....	Almost ready for first issue.
Map of Central Provinces in 2 sheets; scale 16 miles = 1 inch.	160—O.	Outline about half done.
Map of Rajpootana in 2 sheets; scale 16 miles = 1 inch.	210—S.C.	Writing well advanced; both plates put down for more urgent work.
Map of Central India Agency in 2 sheets; scale 16 miles = 1 inch.	505—O.	Outline done to both of the sheets; writing just commenced; plates put down for more urgent work.
Map of Assam; scale 16 miles = 1 inch.	30—O.W.	Corrections and additions to outline and writing, done.
Index Chart to the Great Trigonometrical Survey of India.	.....	Corrections, additions, and repairing outline and writing, completed.
India, 80 miles in 2 sheets ...	.....	Names of all civil and military stations inserted, plate put aside for other important work.
India, 96 miles = 1 inch ...	.....	Ditto ditto ditto.
	2,192	Outline and writing.
Map of the Himalayan routes; scale 16 miles = 1 inch.	.....	Outline, corrections, and additions done; plate put down for more urgent work.
Chart of Colombo Harbour. (For the Marine Survey Department.)	.....	Additional soundings completed. Plate finished.
Plate 3	.....	Pendulum operations in India engraved and finished.
Alterations and additions of new imprints, map heading, and dates.	.....	Engraved and finished.

B.

Progress Report of the Engraving Branch from the 1st October 1878 to the 30th September 1879.

Number.	Outline and writing.	Hills and sand-hills.	New Atlas Sheets Completed and Published.	
Atlas Sheets.	Sq. in.	Sq. in.		
35 N.-E. ...	16	148	Full sheet	Transferred.
90 S.-W. ...	.....	17	Ditto	Ditto.
91 S.-W. ...	32	35	Ditto	Ditto.
93 N.-W. ...	32	135	Ditto	Ditto.
	80	335		
		Hills.	New Atlas Sheets in hand.	
12 S.-E. ...	82	41	Outline, writing and hills, done as far as drawing, almost full up to margin.	
13 N.-E. ...	200	.....	Outline and writing completed as far as drawing; three-fourths of heavy sand-hills completed; the remaining portion of fresh survey up to margin, outline done, writing just commenced.	
		Sand.		
18 S.-W. ...	.....	58		
		Sand.		
18 N.-W. ...	90	102	Writing up to margin finished; heavy sand-hills half completed, in progress.	
		Sand.		
18 N.-E. ...	.....	150	Writing, heavy sand-hills, and jungle to three-fourths of the plate, finished; plate put down; waiting orders.	
19 N.-E. ...	10	.....	Small portion of outline, one-fifth completed; writing just commenced.	
22 S.-E. ...	46	.....	New portion of fresh survey, one-fourth outline and writing completed; plate put down for want of hands.	

Number.	Outline and writing.	Hills and sand-hills.	New Atlas Sheets in hand.	
Atlas Sheets.	Sq. in.	Sq. in.		
22 S.-W. ...	62	.....	Writing finished; hills well advanced, in progress.	
22 N.-E. ...	62	.....	Outline done; writing to about one-fourth of the plate completed, in progress.	
22 N.-W. ...	39	.....	Outline and writing almost up to margin, completed; plate put down for want of hands.	
23 N.-E. ...	79	Sand. 11	Outline, writing, and heavy sand-banks to three-fourths of the plate completed; plate put down for want of hands.	
33 N.-W. ...	.....	Sand. 36	Sand-hills to half the plate, done; plate finished as far as drawing; plate put down; waiting orders.	
33 S.-W. ...	117	.....	Writing three-fourths done, in progress.	
35 S.-W. ...	.....	.....	Outline just commenced.	
36 S.-E. ...	14	.....	Corrections and writing as far as drawing done; plate put down; waiting orders.	
37 N.-E. ...	123	Hills. 41	Hills well advanced; new portion of fresh survey outline done; writing just commenced.	
53 S.-W. ...	178	.....	Outline and writing completed up to margin.	Transfer taken for preliminary edition.
66 N.-E. ...	133	.....	Writing and corrections, done; waiting hill drawing.	
66 S.-W. ...	210	.....	Outline and writing up to margin, completed; waiting hill drawing.	
66 S.-E. ...	146	.....	Outline and writing up to boundary, completed; waiting hill drawing.	
91 N.-W. ...	143	Hills. 25	Outline and writing up to margin, completed; hills well advanced, in progress.	Ditto.
92 N.-W. ...	193	Hills. 20	Writing and corrections up to margin, completed; hills just commenced.	Ditto.
92 S.-W. ...	.....	Hills. 91	Hills well advanced; plate put down for more urgent work.	
129 S.-W. ...	138	.....	Outline and writing as far as drawing, completed; waiting hill drawing.	
129 N.-E. ...	87	.....	Outline and writing, done to about half the plate; waiting orders.	
129 S.-E. ...	.....	.....	Outline up to margin, just commenced.	
130 S.-E. ...	.....	.....	Taking out portion of old work and engraving new survey; outline just commenced.	
130 N.-E. ...	123	20	Outline and writing to half the plate completed; hills just commenced, in progress.	
131 N.-E. ...	61	61	Writing and hills finished to one-fourth of the plate; plate put down; waiting orders.	
138 N.-W. ...	13	.....	Outline as far as drawing, completed; writing just commenced, in progress.	
138 S.-W. ...	9	.....	Outline as far as drawing completed; writing will be put in hand as soon as possible.	
	2,438	991		
			Heavy Additions and Corrections to Atlas Sheets.—New Work.	
8 S.-E. ...	31	.....	Heavy portion of fresh survey, outline done; writing just commenced.	
32 S.-E. ...	8	Sand. 40	New portion and heavy additions to sand-hills, done; plate put down; waiting orders.	
33 N.-E. ...	.....	Sand. 50	Heavy portion of sand-hills, done; plate finished	
71 N.-E. ...	40	.....	Outline and writing of new survey, completed; hills commenced.	
72 N.-E. ...	20	25	Heavy portion of new survey, writing and hills, completed; under examination and orders.	
66 N.-W. ...	119	.....	Heavy additions; writing completed; waiting orders to go on with the hills.	
125 N.-E. ...	.....	2	Small portion of hills added.	
131 S.-W. ...	.....	16	Hills as far as drawing, completed.	
17 full sheet ...	.....	.....	Small portion of railway engraved.	
54 ditto ...	.....	26	Heavy additions of new survey, completed.	
65 ditto ...	46	27	Portion of fresh survey, writing and hills, done; taking out large portion of old work for additional new survey; outline finished; under examination and orders.	
	2,702	1,187	Total square inches of new work.	

NUMBER.	Outline and writing.	Hills and sand-hills.	REPAIRING OF OLD FULL ATLAS SHEETS.
Full sheet.	Sq. in.	Sq. in.	
41	.....	361	Heavy sheet, writing recut; hills under repairs; well advanced, in progress.
47	650	.....	Writing repaired; plate put down.
48	464	.....	Ditto ditto ditto.
50	594	.....	Ditto ditto; plate put down by order.
55	.....	294	Heavy sheet, repairing; hills well advanced, in progress.
57	.....	302	Heavy sheet, repairing; hills completed.
60	.....	.....	Small portion of writing repaired; plate put down for more urgent work.
73	.....	180	Repairs to old portion of hill work, done; writing being recut, in progress.
78	.....	.....	Repairing small portion of hill work; plate put down again for more urgent work.
88	500	.....	Heavy sheet, writing recut, completed.
102	464	.....	Ditto ditto nearly completed, in progress.
106	700	44	Heavy sheet, writing recut; repairing hills, just commenced.
111	117	.....	Writing half repaired; plate put down for more urgent work.
112	850	86	Writing and hills, repaired; completed.
113	.....	.....	Slight hill work repaired.
115	15	190	Writing recut; heavy sheet of hill work, under repairs, in progress.
116	153	.....	Heavy sheet of writing, recut, completed.
120	396	.....	Ditto ditto very near half done, in progress.
	4,903	1,457	Total of square inches of repairs.

Progress Report of the Engraving Branch from the 1st October 1878 *to the 30th September* 1879.

ATLAS SHEETS PROJECTED AND BORDERS CUT.

16 Plates ... Outside names and figures, in progress; all four quarters of 21, 60, 67, and 49.
9 Do. ... The note on the south-west sheet of the Indian Atlas has been engraved on the following sheets:—2 S.-W., 8 S.-W., 10 S.-W., 11 S.-W., 44*a* S.-W., 51 S.-W., 64 S.-W., 87 S.-W., and 127 S.-W.
4 Do. ... Slight additions have been added to Atlas sheets 90 N.-W., 91 N.-E., 63*a* N.-W., and 45 N.-E.
Number of plates in hand during the year has been 109.

Copper-plate Printing.

	Rs.
Proofs	1,912
Transfers	618
Impressions	3,239
Total ...	5,769

(SD.) C. W. COARD,
Superintendent, Engraving Branch.

(SD.) EDWARD H. STEEL, *Captain,*
Assistant Surveyor-General.

SURVEYOR-GENERAL'S OFFICE,
30th September 1879.

Table A.

Tabulated Statement of the principal Records prepared in the several Executive Offices of the Revenue Branch for the year ending 30th September 1879.

Province	Survey Party.	District.	For Deputy Surveyor-General's Office.											For Settlement Department.	
			Cadastral.			Atlas sheets 4″ = 1 mile.	Quarter sheets 2″ = 1 mile, or standard 1″ maps.	Triangulation charts and index maps.	Area traverses.		Field books.		Original field plans.	Traces of sheets.	Khasra field area statements.
			Sheets.	Amin's field sketch books.	Field area statements.				Main circuit with azimuth computation.	Village or sub-circuit.	Main circuit.	Village or sub-circuit.			
			No.	Vols.	Vols.	No.	No.	No.	Vols.	Vols.	Vols.	Vols.	No.	No.	Villages.
								CADASTRAL SURVEYS.							
N.-W. Provinces	4th	Moradabad	.....	.....	.....	.....	.....	1 Dist. index map 2 Level ,, maps	.....	.....	.....	.....	.....	.....	.....
		Ghazipur	245	.....	2 (197 vil.)	.....	5 quarter sheets	.....	1	4	4	9	.....	.....	197
	5th	Banda	589 (*a*) 280	.....	.....	56 rendered complete.	.....	.....	1	1	1	3	589	287	223
		Mirzapur	.....	.....	.....	.....	*	.....	1	1	1	4	.....	.....	.....
	6th	Jaunpur	784	.....	.....	11 rendered complete.	12 (2″ quarter sheets.)	1 Index map	3	3	3	27	.....	.....	867
Assam	8th	Cachar	(*b*) 163	4 on 64″ 50 on 32″	.....	.....	.....	Ditto	1	1	1	1	8 on 32″ 29 on 16″	163	19
Bengal	7th	Pooree, Khorda Estate.	1,417	.....	.....	17	.....	2 Index maps on ¼″	1	2	1	6	1,417	(*c*) 2,349	(*c*) 903
	9th	Cuttack	1,669	.....	.....	22	.....	2 Ditto ...	1	4	1	12	1,669	.....	(*d*) 798
	.....	Lohardugga, Barkagarh Estate, &c.	247 on 16″ 120 on 32″	3	2 volumes...	12	.....	1 Index map on ¼″ ...	2	1	.....	1	.....	367 *	35
British Burma	.....	Hanthawaddy (Rangoon).	57	1 (22 kwengs)	.....	.....	.....	1 Ditto on 1/12″	1	1	1	1	.....	22 (kwengs) in duplicate.	22 kwengs.
			Horizontal and vertical angle-books.	Triangle computations.	Computation of heights.			VILLAGE AND TOPOGRAPHICAL SURVEYS.							Detail areas of villages.
Punjab	1st	Bannu and Dera Ismail Khan.	.....	.....	.....	(*e*) 88	.....	3 Index msps on ¼″ (in duplicate).	.....	.....	.....	.....	88	47	74
		Rawalpindi ...	.....	.....	.....	(*f*) 14	.....	.....	1	1	1	2	14	.....	.....
		Shahpur (Sakesar Sanitarium).	.....	.....	.....	2 (on 16″ scale)	.....	1 Index map to plane-table sections.	.....	.....	.....	.....	.....	2 on 16″ scale	.....
	2nd	Sirsa	.....	.....	.....	(*g*) 62	9 on 1″ scale	1 reduction for Atlas of India.	1	2	1	8	(*f*)	93 on 4″	.....
		Jhelum	.....	.....	.....	(*h*) 16	.....	.....	.....	.....	.....	.....	.....	.....	.....
N.-W. Provinces	3rd	Saharanpur ...	.....	.....	.....	.....	(*i*) 23 (fine) on 2″ for reproduction. 18 (exact.) on 2″ for reduction.	.....	.....	.....	.....	.....	86 (*j*) 7	.....	.....
		Muzaffarnagar ...	.....	.....	.....	.....	.....	.....	1	5	71	17	32	.....	.....
		Umballa	.....	.....	.....	8 on 4″	.....	.....	.....	.....	.....	.....	8	.....	.....
	4th	Budaun	.....	.....	.....	.....	.....	1 Dist. index map ... 2 Level ,, maps... 2 Sheet ,, ...	.....	3	.....	11	.....	32 on 4″	569
Bombay	10th	Ahmednagar and Poona.	4 volumes	2 volumes (*k*)		.....	12 (on 2″ scale)	1 On ¼″ (skeleton) for Indian Atlas. 1 Triangulation chart 1 Index map to traverse work.	1	1	1	1	24 (on 2″)	16 on 2″ (skeleton).	.....
	11th	Sholapur and Satara	1 volume	2 ditto		16 (showing fields.)	18 (on 2″ scale)	1 Triangulation chart 2 Index maps ...	2 volumes		3 volumes		32 (on 4″) 28 (on 2″)	.....	.....

(*a*.) Revision survey of pargana Chiribu.
(*b*.) 114 sheets, which have been surveyed in boundary only, will be made over to the Settlement Officer for completion.
(*c*.) Of these 414 villages in 932 sheets are skeleton plans with offsets.
(*d*.) Of these 2 are portions of villages.
(*e*.) 17 sheets partially done in previous season.
(*f*.) 17 sheets on 20″ scale of Murree Sanitarium also completed.
(*g*.) The 4″ maps are original field sheets.
(*h*.) In skeleton only.
(*i*.) Surveyed in season 1877-78, completed in 1878-79.
(*j*.) Patri forest mapped in 5 sheets on 4″ scale. Saharanpur city, &c., in 4 sheets on 6″ scale.
(*k*.) 1 volume computation of rectangular co-ordinates of great trigonometrical and triangulated stations. Traverse data of main circuit 54 to 58, and contained sub-traverses for Settlement Department.

Deputy Surveyor-General's Office;
Calcutta, 1st January 1880.

F. CODDINGTON, *Major,*
Deputy Superintendent at Head-Quarters.

Table B.

Statement of Work performed in the Drawing and Compiling Office of the Deputy Surveyor-General from 1st January to 31st December 1879.

Revenue Survey Maps.	Scale.	Remarks.
Punjab.	Inch. Mile.	
Districts Bannu and Dera Ismail Khan, in 41 sheets, 30′ × 15′ ..	1 = 1	133 sheets on scale of 4″=1 mile, comprising 1″ standards Nos. 1, 4, 5, 8, 9, 12, 13, 16, 17, 20, 21 examined and sent to press for photograph reduction to half scale. The 2″ blue prints of sheets Nos. 24, 25, 28, 29, 32, 33, 36, 39, have been re-drawn in black for reduction to 1″, and are under examination for press. These sheets embrace the portion of the two districts lying west of 71° longitude.
District Rohtak, congregated village sheets, 500 × 400 chains ..	4 = 1	85 sheets examined, rendered suitable for photography, and sent to press for reproduction.
Murree Sanitarium in 17 sheets ..	20 = 1	All examined, lines of latitudes and longitudes inserted, and sheets completed for photo. reduction to half scale in six sheets.
Shekh Budin Sanitarium in 8 sheets..	20 = 1	All examined, lines of latitudes and longitudes inserted, and sheets completed for photo. reduction to half scale in two sheets.
Rewari .. Farukhnagar .. Sohna .. } Municipal towns, district Gurgaon	16 = 1	Examined and completed for photo. reduction and publication.
North-Western Provinces.		
District Muttra in 7 sheets, 30′ × 15′	1 = 1	2″ blue prints of sheets Nos. 1, 3, 5, 6, 7, drawn in black for reduction to 1″, and under examination for press. Drawing of sheets Nos. 2 and 4 in progress.
District Moradabad and pargana Kashipur of Tarai district in 13 sheets, 30′ × 15′	1 = 1	Graticule line inserted on 4″ congregated village sheets and sent to press for photo. reduction to 2″ scale previous to being re-drawn in black for final reduction to 1″.
District Moradabad, preliminary district map and sheet index ..	¼ = 1	Examined and sent to press for photo. reproduction.

Table B—*continued.*

Revenue Survey Maps.	Scale.	Remarks.
Bengal.	Inch. Mile.	
District Midnapore, in 17 sheets, 30′ × 15′	....	The drawing of 2″ blue prints of sheets Nos. 2, 3, 6, 9, 12, 13, 15, 16, 17, completed; examination in hand. Of the remaining sheets, Nos. 1, 4, 7, 10, containing jungle mehals surveyed on 1″ scale, have been drawn by the Surveyor, and await examination for press; while sheets 5, 8, 11, 14, including surveys on 1″ and 4″ scales, are under preparation in head office. Of these latter sheets, the drawing of No. 5 has been completed.
District Maldah in 8 sheets, 30′ × 15′	1 = 1	Drawn for lithography, examined, and sent to press.
District Jalpaiguri in 13 sheets, 30′ × 15′	1 = 1	Skeleton standards projected showing outlines of Parganas, and original maps divided into 5′ squares for guidance of Litho. press.
District Monghyr on rectangular projection	1 = 1	Sheets Nos. 7, 8, 14, 15, 16, 17, completed for a second edition, including transfers from Bhagulpore district.
Assam.		
District Lakhimpur on rectangular projection	1 = 1	Sheets Nos. 1A and 5A drawn on 2″ scale for reduction to 1″ and publication.
Bombay.		
Deccan Topographical Survey, 2″ = 1 mile to latitude 17°, including the Konkan, in 96 sheets, 30′ × 15′..	1 = 1	The 2″ sheets Nos. 19, 23, 24, 38, 44, 48, and 4″ sheet No. 54 (in 16 sections) examined and completed for publication. The 2″ sheets Nos. 39, 39A, 45, the greater portion of which extend into the Nizam's dominions, were reduced to 1″, and completed to margin from the Hyderabad Circar maps of the old topographical survey of 1835 for photo. reproduction and publication.
Number of sheets published to date, 42.		
Index Maps.		
District Dera Ismail Khan } in one.	On various scales.	Explanatory of the areas completed and remaining for survey in the several districts, for publication with the annual report for 1878-79.
„ Bannu .. }		
„ Rawalpindi		
„ Sirsa		
„ Saharanpur .. }		
„ Muzaffarnagar .. } in one.		
„ Meerut .. }		
„ Ghazipur		
„ Banda		
„ Mirzapur		
„ Jaunpur		
„ Pooree .. } in one.		
„ Cuttack .. }		
„ Cachar		
Deccan Topographical Survey ..		
Barkagarh Estate		
British Burma, District Hanthawaddy		

Table B—*continued.*

Miscellaneous Maps, Tracings, &c.	Scale.	Remarks.
	Inch. Mile.	
Oudh province, in 53 sheets, colored to show pargana boundaries ..	1 = 1	For Surveyor-General's Office.
Extracts from several sheets of districts Tipperah and Dacca, with copy of survey traverse data ..	4 = 1	For Deputy Collector, Dearah Survey.
Trace of boundary between districts Goalpara and Rungpore, with traverse data	1&4 = 1	For guidance of the Surveyor in re-laying the boundary.
Traces of boundary between districts Midnapore and Manbhoom (new and old surveys)	4 = 1	For Civil Superintendent of Survey.
Plot of villages bordering the Ramganga River, districts Bareilly and Budaun, according to Captain Burgess' survey of 1852-53 ..	4 = 1	Two sets—one for Board of Revenue, the other for Deputy Superintendent of Survey, Fourth Division.
Trace of Atlas sheet of district Bareilly according to Mr. Campbell's survey of 1870-71 ..	4 = 1	
Trace of boundary between districts Karnal and Saharanpur, showing Jumna river and adjoining country	4 = 1	For Deputy Superintendent of Survey, Second Division.
26 traces from original village plans of district Umballa on Saharanpore	4 = 1	
Traces and traverse data of 14 villages of district Patna	4 = 1	For Collector of Patna.
Trace of index to spirit levels in district Banda, season 1877-78 ..	2 = 1	For Executive Engineer, Allahabad Division.
Traces of portions of Deccan sheets touching on the work of 1878-79..	2 = 1	For Deputy Superintendents of Survey.
Map Coloring.	No. of sheets.	
Maps colored for Surveyor-General's Office	101	
Maps colored for Revenue Survey Office	101	
Maps colored for despatch to India Office	680	
Maps colored for issue to Government officials	1,119	The cadastral maps are not included in this return.
Total ..	2,001	
Examination of Proof-sheets.		
Photozincograph proofs ..	115	
Lithograph do.	141	

Table B—*concluded.*

EXAMINING AND COMPUTING SECTION.

Original congregated village sheets, 4″=1 mile—

Districts	Dera Ismail Khan and Bannu, season	1876-78	Finally examined, corrected, and defects pointed out to Executive.
District	Sirsa	„ 1876-79	Preliminary examination made prior to accepting and lodging the maps in record room.
Do.	Moradabad	„ 1871-77	
Do.	Banda	„ 1874-76	
Do.	Shahabad	„ 1876-78	Examined for publication.
Do.	Gya and Patna	„ 1876-78	
Do.	Ganges Dearahs of districts Furreedpore and Backergunge	„ 1876-77	Finally examined and reviewed. Revised village boundaries inserted on Midnapore maps.
Do.	Midnapore	„ 1876-78	

COMPUTATIONS.

Traverse data.—The main circuit and village traverses and computations of the following divisions were examined and reviewed during the year:—

1st or Dera Ismail Khan and Bannu districts for season...	1876-78
2nd or Sirsa district	1876-79
6th or Gya and Patna districts	1877-78
6th or Jaunpur district	1877-78
8th or Shahabad district	1875-77
Barkagarh and Chota Nagpore estates	1876-79

Latitudes and Longitudes of the necessary revenue survey stations were computed for the purpose of laying down graticule lines on the one-inch maps of the Ganges Dearah survey along districts Furreedpore and Backergunge. The values of revenue survey co-ordinates of sheet corners, and other points, were determined for laying down the graticule lines on the four-inch village sheets of districts Moradabad, Dera Ismail Khan, and Bannu, and on the one-inch sheets of district Jalpaiguri.

Miscellaneous.—Calculated from origin of survey the co-ordinate values of all trijunction stations and pukka pillars of the forest tracts of district Bareilly, and inserted the same on the four-inch printed copies of sheets for Superintendent, Forest Surveys.

Prepared area statement of parganas of district Agra according to revised district and parganas limits.

Revised area of district Baraich according to new boundary along Nepal frontier.

Corrected the areas of villages in district Midnapore according to revised boundaries.

Inserted main circuit stations and co-ordinates on one-inch standard sheets of Bahawalpur State for Surveyor-General's Office.

Table of co-ordinates of corners of 5 min. squares calculated from centre of each degree for latitudes 24° to 28°; examination and preparation of annual return tables, &c.

DEPUTY SURVEYOR-GENERAL'S OFFICE;
Calcutta, the 1st January 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

Table C.

Statement of Work performed in the Cadastral Section of the Deputy Surveyor-General's Office during the year ending 31st December 1879.

Cadastral Maps.	Number of sheets.	Remarks.
North-West Provinces.		
Examined and rendered suitable for photography ...	3,305	Scale 16″ to a mile.
Traced and examined for lithography... ...	865	
Printed maps examined and corrected... ...	520	
Proofs examined for publication previous to press order	4,503	
Printed maps colored by extra draftsmen, but examined in office	10,967	
Bengal.		
Examined and rendered suitable for photography and sent to press	341	Khorda estate, scale 32″ to a mile.
Proofs examined for publication previous to press order	212	Behar Irrigation Tracts, scale 32″ to a mile.
Printed maps colored by extra draftsmen, but examined in office	1,192	

Deputy Surveyor-General's Office;
Calcutta, the 1st January 1880.

F. CODDINGTON, *Major,*
Deputy Superintendent at Head-Quarters.

No. 857L, dated Calcutta, the 5th January 1880.

From—Captain R. V. Riddell, R.E., Assistant Surveyor-General, in charge Lithographic Branch, Surveyor-General's Office,

To—The Surveyor-General of India.

I have the honor to submit returns showing the detail and amount of work completed in the Lithographic Office between 1st October 1878 and the 30th September 1879.

Personnel.

Captain R. V. Riddell, R.E., in charge.
Mr. E. Jevezy, Head Assistant and Chief Draftsman.
Mr. H. L. Lepage, Mr. J. Musgrove, Bulloram Nath, Mohamed Azim, Sobhun Bukah and 26 others. } *Draftsmen.*
Mr. H. Niven, Cromo. Litho. Printer.
Mr. E. DePyvah, Printer.
One Press Assistant and 20 others.
Three native clerks.

2. The total number of maps, plans, diagrams, &c., printed during the year amounts to 1,31,794 copies, which represents 1,39,366 pulls or impressions. Of these, 91,657 copies were for other departments, and, as usual, were of very varied character, although the number of copies supplied have been only 91,657 as compared to 1,03,015 during the previous year. The number of sheets drawn, amounted to 281, or 45 in excess of those drawn in the preceding twelve months.

3. The following lithographed district maps have become available during the year:—

District Rajshahye.
Ditto Furreedpore.

Scale 1 inch = 1 mile: the former in 11 sheets and the latter in 13 sheets, measuring 44″ × 25;″ and 2 sheets of the district Maldah, which have been drawn, are awaiting publication.

4. Maps of the districts marginally noted, on the scale of 1 inch = 4 miles, obtained by transfers from the copper-plates of the sheets of the Atlas of India: two have been published after corrections being made on the stones. Alterations to the boundaries of the districts, and internal sub-divisions, lines indicating railways, roads, canals, &c., and five other district maps of a similar nature, are in various stages of progress.

District Bahraich.
Ditto Purneah.
Ditto Rungpore.
Ditto Dinagepore.
Ditto Gya.
Ditto Julpigoree.
Ditto Shahabad.

General Maps.

Full sheet, Nos. 68, 102, 103, 104, 107, 111, 112, and 121.
Quarter sheet, No. 5, North-east.
,, ,, No. 34, North-west.
,, ,, No. 35, North-east.
,, ,, No. 87, North-west.
,, ,, No. 91, North-west.
,, ,, No. 92, South-east.
,, ,, No. 93. South-east.

5. Atlas of India, scale 1 inch = 4 miles. The sheets specified in the margin were obtained by transfers from the engraved plates and coloured by stone printing.

The geological map of Punjab Salt Range in two sheets, scale 1 inch = 4 miles, was prepared during the year and printed in seven colours, which entailed 10,104 pulls. This work has been a very successful production.

District Sealkote, scale 1 inch = 2 miles, for Punjab Government; map of Fyzabad and Raebareli Divisions, scale 1 inch = 4 miles, for Government, North-Western Provinces and Oudh, Public Works Department.

6. One of the most laborious jobs of the year has been the preparation of publishing a map of India, scale 1 inch = 64 miles, in two sheets, with hills in chalk: one sheet has been completed fairly successfully, and the other is expected to be ready by April next. During the year two young native draftsmen have been specially trained to draw hills by vertical lines on stone direct, and have made very satisfactory progress; and one of the lithographic draftsmen engaged last year has made good progress both in chalk drawing and general lithographic drawing with the brush.

7. Statement A shows the detail of the departmental work completed during the year, amounting in value to Rs. 20,350.* Statement B shows the amount and value of work done for other departments. The number of subjects treated amount to nearly one-third more of those prepared for the Survey Department, and the number of impressions nearly half more than that of the regular departmental work, as represented by 89,211 pulls for other departments, against 50,155 for the regular work. The value of the work done for other departments amounts to Rs. 18,798.* Statement C shows the abstract of the whole work completed during the year, as well as the outlay in salaries and contingent charges, actually spent.

* Exclusive of cost of transfers, &c., by Typographic Branch, which would be approximately one-fourth of Rs. 2,089, to other departments, and the remainder to departmental maps, &c.

A.

Statement of Departmental Work done by the Lithographic Branch, Surveyor-General's Office, between the 1st October 1878 and 30th September 1879, for the Survey Department.

Description of Maps.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Value.	Remarks.
							Rs. A. P.	
New Maps, &c., drawn and printed during the year.								
General Maps.								
Map of Assam in 9 sheets, sheets Nos. 3 and 5.	.....	11 inch = 8 miles.	Imperial	2	...	.....	.....	1,507 8 4	Not yet printed.
Sketch of the countries between Hindustan and Caspian Sea.	Chalk hills redrawn.	1 inch = 64 miles	Double elephant.	1	...	.....	.....	692 13 0	Ditto.
Index Maps.								
Index to the 1-inch sheets of district Dinagepore.	Corrections and additions drawn.	.....	Super royal.	1	...	282	282	40 2 3	
Index to the 1-inch sheets of district Furreedpore.	.....	.....	½ sheet Imperial.	1	...	.....	.....	69 10 8	Not yet printed
Revenue Survey Maps.								
Map of district Rajshahye in 11 sheets, sheets Nos. 5, 8, 9, 10, and 11.	.....	1 inch = 1 mile	Double royal.	5	...	.....	.....	1,709 13 1	Not yet printed.
Map of district Maldah in 7 sheets, sheets Nos. 3 and 5.	.....	1 inch = 1 mile	Ditto	2	...	.....	.....	144 6 5	Ditto.
Maps transferred and printed from engraved sheets of the Atlas of India, and from standard stones.								
General Maps.								
Map of Indian Atlas, full sheets, Nos. 68, 102, 103, and 112.	.....	1 inch = 4 miles	Antiquarian.	4	...	310	310	220 2 7	
Map of Indian Atlas, full sheets, Nos. 104, 107, 111, and 121.	Corrections and additions drawn.	Ditto ...	Ditto ...	4	...	407	407	537 13 8	
Map of Indian Atlas, quarter sheets, No. 5 N.-E., 87 N.-W., 92 S.-E., and 93 S.-E.	Color stone prepared only.	Ditto ...	Half sheet atlas.	...	603	.....	603	64 8 0	
Map of Indian Atlas, quarter sheets, Nos. 34 N.-W., and 91 N.-W.	Corrections and color stones prepared.	Ditto ...	Ditto ...	2	195	65	260	92 15 6	
Map of Indian Atlas, quarter sheet, No. 35 N.-E.	Color stone prepared.	Ditto ...	Ditto ...	1	39	15	54	27 11 1	
Map of India showing the mean heights of compartments.	Corrections and additions drawn.	1 inch = 128 miles	Imperial...	1	...	375	375	108 8 0	
District Maps.								
District Buhraitch	Corrections, boundaries, &c., drawn and color stones prepared.	1 inch = 4 miles	Atlas ...	1	150	50	200	167 15 6	
Ditto Purneah	Ditto ...	Ditto ...	Antiquarian.	1	150	50	200	203 15 6	
Ditto Rungpore	Corrections, boundaries, &c., drawn.	Ditto ...	Double elephant.	1	...	.....	.....	60 15 0	Not yet printed.
Ditto Dinagepore	Ditto ...	Ditto ...	Double royal.	1	...	.....	.....	43 6 8	Ditto.
Ditto Gya	Ditto ...	Ditto ...	Ditto ...	1	...	.....	.....	67 3 0	Ditto.
Ditto Julpigoree	Ditto ...	Ditto ...	Atlas ...	1	...	.....	.....	43 6 8	Ditto.
Ditto Shahabad	Ditto ...	Ditto ...	Antiquarian.	1	...	.....	.....	52 15 6	Ditto.
Maps, &c., drawn previously, but printed during the present year.									
General Map.									
Map of Assam in 9 sheets, sheet No. 4.	.....	1 inch = 8 miles	Imperial...	1	150	50	200	633 9 6	
Revenue Survey Maps.									
Map of district Dinajpore in 13 sheets, sheets Nos. 7, 9, 10, 12, and 13.	.....	1 inch = 1 mile	Double royal.	5	...	1,410	1,410	3,499 0 0	
Map of district Rajshahye in 11 sheets, sheets Nos. 1, 2, 3, and 4.	.....	Ditto ...	Do. ...	4	...	1,128	1,128	702 2 0	
Map of district Furreedpore in 13 sheets, sheets Nos. 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, and 12.	.....	Ditto ...	Do. ...	11	...	3,102	3,102	3,409 14 0	
Maps, &c., transferred previously from the engraved sheets, but printed during the present year.									
General Map.									
Map of India illustrative of the Pendulum Operations of the Great Trigonometrical Survey of India during the years 1865 to 1873.	.....	1 inch = 128 miles	Imperial...	1	...	375	375	226 4 0	
Carried over ...	.....	.....	...	53	1,222	7,619	8,911	15,116 11 11	

Description of Maps.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Value.	Remarks.
							Rs. A. P.	
Brought forward ...	.....	.....	53	1,292	7,619	8,911	16,116 11 11	
Reprints.								
General Maps.								
Map of North-West Frontier, Peshawar to Cabul, in 2 sheets.	.....	1 inch = 4 miles	Double elephant.	2	...	409	409	223 12 0	
Skeleton map of Punjab and surrounding countries.	...	1 inch = 33 miles	Atlas ...	1	...	152	152	40 4 11	
Outline map of India showing the progress of the Imperial Survey up to 1st October 1878.	Corrections and color stones prepared.	1 inch = 128 miles	Imperial...	1	400	.....	400	125 2 6	
Outline map of India	.....	Ditto.	Do. ...	1	...	250	250	35 0 0	
Ditto ditto, in 2 sheets	Corrections and additions drawn.	1 inch = 64 miles	Double royal.	2	...	50	50	48 1 4	
Map of Eastern Bengal, Burmah, China, and parts of Siam, in 4 sheets.	.....	1 inch=32 miles	Imperial...	4	..	202	202	162 8 0	
Map of the province of Bengal, Behar, and Orissa under the jurisdiction of Lieutenant-Governor of Bengal.	Corrections drawn.	1 inch=32 miles	Double royal.	1	...	100	100	18 4 4	
Index Maps.								
Index to the sheets of Gwalior and Central India Topographical Survey, No. 1 Party.	Corrections and color stone prepared.	.....	Half-sheet super royal.	1	401	50	451	83 2 3	
Index to the sheets of the Kandesh and Bombay Native States Survey, No. 2 Party.	Color stone prepared.	.....	Foolscap...	1	401	50	451	52 13 3	
Index to the sheets of Ganjam and Orissa Topographical Survey, No. 3 Party.	Corrections and color stone prepared.	.....	Half-sheet double royal.	1	401	50	451	63 7 3	
Index to the sheets of North-East Division, Central Provinces Topographical Survey, No. 4 Party.	Color stone prepared.	.....	Foolscap...	1	401	50	451	52 13 3	
Index to the sheets of Bhopal and Malwa Topographical Survey, No. 5 Party.	Ditto ...	.....	Ditto ...	1	401	50	451	52 11 3	
Index to the sheets of Garo, Khasi, and Nuga Hills Topographical Survey, No. 6 Party.	Corrections and color stone prepared.	.....	Half-sheet double royal.	1	408	50	458	56 7 6	
Index to the sheets of Rajpootana Topographical Survey, No. 7 Party.	Ditto ...	.....	Ditto ...	1	401	50	451	61 3 3	
Index to the sheets of Mysore Topographical Survey, Nos. 8 and 9 Parties.	Ditto ...	.....	Foolscap...	1	402	50	452	71 3 6	
Index to the Indian Atlas showing the state of the engraving to 1st October 1878.	Ditto ...	.....	Ditto ...	1	440	52	492	61 15 6	
Plan.								
Plan of Calcutta, in 2 sheets ...	.....	6 inch = 1 mile	Double elephant.	2	...	100	100	72 8 0	
Total ...	.....	.....	.....	76	5,348	2,334	14,682	16,398 2 0	
Cadastral maps	.....	.....	.....	41	...	2,091	2,091	839 6 6	
Miscellaneous drawings ...	.....	.....	.....	20	...	4,710	4,710	1,138 8 3	
Forms	.....	.....	.....	27	...	18,654	18,654	1,974 10 2	
Total ...	.....	.....	.....	164	5,348	34,789	40,137	20,350 10 10	

B.

Work done for other Departments.

For what Department.	Number of maps.	Number of sheets.	Number of sheets colored.	Number of sheets uncolored.	Number of copies.	Number of impressions.	Value.
							Rs. A. P.
Foreign Department	40	43	6	37	3,267	2,730	1,992 6 1
Military Department	14	53	6	47	3,538	2,762	2,520 12 2
Department of Revenue, Agriculture, and Commerce	1	1	1	.....	432	1,726	544 3 0
Telegraph Department	1	1	.....	1	480	480	35 0 0
Bengal Office	11	11	.....	11	3,890	3,079	336 15 5
Marine Survey Department	1	1	1	.....	162	486	85 9 0
Sanitary Commissioner	3	3	3	.....	1,122	3,684	773 1 0
Quarter-Master-General	12	23	.....	23	2,721	2,626	1,803 4 11
Meteorological Reporter to the Government of India	8	8	3	5	3,513	6,203	883 11 0
Archæological Survey of India ...	22	22	.....	22	15,783	6,462	1,602 1 3
Geological Survey Office	5	6	4	2	3,419	18,393	1,726 13 1
Miscellaneous drawings	107	109	30	79	53,330	40,580	6,494 3 1
Total ...	225	281	54	227	91,657	89,211	18,798 0 0
Total of Departmental work from Statement A	.....	164	.....	.....	40,137	50,155	20,350 10 10
Grand Total ...	...	445	...	.....	1,31,794	1,39,366	39,148 10 10

C.

Abstract of Drawings and Printing executed at the Surveyor-General's Office, Lithographic Branch, from 1st October 1878 to 30th September 1879.

Subject.	Number of sheets.	Number of copies.	Number of impressions.	Value. Rs. A. P.
General and district maps, &c.	28	4,552	9,869	6,125 12 7
Index maps	10	4,390	8,046	674 9 11
Revenue survey sheet maps, scale 1 inch=1 mile	20	5,640	5,640	9,525 3 6
Plans	2	100	400	72 8 0
Cadastral maps	41	2,091	2,091	839 6 6
Miscellaneous drawings	20	4,710	5,965	1,138 8 2
Forms	27	18,654	18,144	1,974 10 2
	148	40,137	50,155	20,350 10 10
Maps drawn, but not printed	16	.....	.....	.....
Total	165	40,137	50,155	20,350 10 10
Work done for other Departments.				
Miscellaneous maps	53	7,801	14,787	5,617 5 11
Ditto plans and sketches, &c.	201	80,437	56,031	11,453 13 0
Geological maps	6	3,419	18,393	1,726 13 1
	260	91,657	89,211	18,798 0 0
Maps drawn, but not printed	21	.....	.....	.....
Total	281	91,657	89,211	18,798 0 0
Total of Drawing and Printing in Lithographic Branch	445	1,31,794	1,39,366	39,148 10 10
Type Branch.				
Departmental orders	28	5,378	6,278	126 8 0
Memorandum and forms for use of the department	381	1,54,980	1,82,894	2,613 6 0
Forms for Topographical and Revenue Surveys	41	62,660	1,60,610	2,724 8 0
Transfer of headings, foot-notes, references, to published maps	1,543	17,393	17,393	2,088 10 0
Total	1,993	2,40,411	3,67,175	7,553 0 0
		Total Value	... ...	46,701 10 10

Statement of Expenditure of the Lithographic Branch, Surveyor-General's Office, from 1st October 1878 to 30th September 1879.

	Rs. A. P.
Permanent establishment	37,220 10 1
Contingent charges	5,087 10 6
Total	42,308 4 7

SURVEYOR-GENERAL'S OFFICE;
Lithographic Branch,
Calcutta, the 5th January 1880.

R. V. RIDDELL, *Captain*, R.E.,
Assistant Surveyor-General,
In charge, Litho. Branch S.-G. O.

No. 428P, dated Calcutta, the 5th December 1879.

From—Major J. Waterhouse, Assistant Surveyor-General, in charge Photographic Branch,

To—The Surveyor-General of India.

I have the honor to submit the usual tabular statements showing the amount and progress of the work performed in this branch of your office during the past year from 1st October 1878 to the 30th September 1879.

Amount of work.

2. The amount of work performed during the year under report, as compared with the previous year, is shown in the following table :—

	Ordinary Works.				Cadastral Maps, North-Western Provinces.				Remarks.
	1st October 1878 to 30th September 1879.	1st October 1877 to 30th September 1878.	Difference.	Difference in square feet.	1st October 1878 to 30th September 1879.	1st October 1877 to 30th September 1878.	Difference.	Difference in square feet.	
Originals	1,223	1,436	— 213		3,941	3,016	+ 925		
Negatives ...	1,322	1,193	+ 129	+ 1,165·04	3,401	3,376	+ 25	+ 2,778·06	
	4,733·22 s. ft.	3,568·18 s. ft.			26,994·32 s. ft.	23,315·68 s. ft.			
Photographic transfers	1,180	1,139	+ 41	+ 750·16	3,359	3,421	— 62	— 816·26	
	4,310·17 ,,	3,560·01 ,,			25,763·64 ,,	26,579·87 ,,			
Silver prints ...	192	837	— 645	— 1,615·09	.....	.....	...	..	
	422·20 ,,	2,037·29 ,,			.....	.....	...	...	
Pigment prints ...	245	.....	...	...	.....	.....	...	...	
	1,010·92 ,,								
Platinum do. ...	26	...	...	...	.....	.....	...	...	
	20·50 ,,								
Transfers to zinc ...	1,004	1,368	— 364	..	4,182	3,281	+ 881	.	
Number of pulls ...	1,12,014	1,47,165	— 35,151	..	1,03,150	89,000	+ 14,150	..	
Ditto of printed sheets (single) ...	1,44,912	2,07,329	— 62,417	..	1,03,150	89,000	+ 14,150	.	
Number of printed sheets (combined)	1,26,334	1,69,390	— 43,056	..	56,125	51,375	+ 2,750	.	
Proofs	3,159	3,137	+ 22	..	7,528	6,394	+ 1,134	.	

Progress.

3. The purely photographic part of the ordinary work of the office shows a small increase, but there is a considerable falling off in the number of originals received for reproduction, and in the trasfers to zinc and zinc-printing. This is chiefly attributable to the fact that last year 86·5 transfer tracings of the Bengal Cadastral Survey were included under this head, whereas in the present year only 411 sheets have been done, and such work is no longer coming in. On the other hand, the cadastral work for the North-Western Provinces Government shows a slight falling off in the photographing, and an increase in the number of originals received and in the zinc-priting, due to 690 sheets having been transferred direct to zinc from transfer tracings instead of being photographed. Comparing the whole out-turn of the presses, as calculated by the pulls, there is a falling off of 20,979 pulls, the out-turn of the past year being 2,18,323 (inclusive of proofs), against 2,39,302 of the previous year.

Expenses of working.

4. The approximate expenses of working the office during the financial year 1878-79 is shown, as far as the materials are available, in the following table, which shows a diminution of expenditure, amounting to about Rs. 10,000, under that of the previous year, chiefly in stores, the cost of establishments, and contingencies having been higher :—

Office.	Rs.	A.	P.	Rs.	A.	P.
Superintendent's salary from 1st April 1878 to 31st March 1879 ...	13,879	1	9			
Sanctioned establishment	24,206	2	8			
House-rent and taxes	4,488	12	0			
Contingencies	2,036	1	10			
				44,610	2	3
Chemicals and stores received from England	7,329	1	8			
Ditto received from Government Medical Store Department ...	57	15	3			
Stores and materials received from other Government departments ...	123	5	11			
Cost of paper received from England and Government Stationery Department	13,606	11	9			
Books and periodicals received from England	129	11	3			
				21,246	13	10
Cadastral Surveys, North-West Provinces.						
Establishment	17,919	15	10			
Contingencies	*3,937	1	0			
				21,857	0	10
Chemicals and stores received from England	12,145	11	3			
Ditto from Government Medical Store Department	249	3	0			
Stores and materials received from other Government departments ...	24	11	0			
Cost of paper received from England through Government Stationery Department	2,215	4	0			
				14,634	13	3
Total				1,02,348	14	2

* In addition, Rs. 4,534-0-6 was paid to Deputy Surveyor-General's Office for cost of tracings and printing by contractors

5. The total number of these maps printed off during the year has been 4,126, or 566 more than last year. More might have been done, but in the month of May it was found that owing to all arrears having been cleared off by tracings the supply of originals was insufficient to keep the cameras and presses working at the rate they had been doing for the earlier months of the year, and it appears that in future the number of sheets coming in yearly will not exceed 3,000, which is scarcely sufficient to keep the present establishment fully at work. In order to find full employment for the zinc correctors and economise chemicals and expense, the smaller and more open villages are not photographed, but traced on tracing paper and transferred direct to zinc.

Cadastral maps of the North-Western Provinces.

6. Up to the month of April the two extra presses mentioned in my last year's report as being utilized for printing the sheets of the Bengal Irrigation Surveys from tracings were kept employed, and 411 sheets were printed off. The work then ceased, and as no more was likely to come in, the extra establishment was dismissed.

Cadastral maps of Bengal.

7. The ordinary processes of the office have remained as reported last year. The supply of pyroxyline for making collodion having run short, experiments were made with a sample of papyroxyline given me by the Autotype Company in London last year. It was found to work very well, and a small quantity was obtained from the Company for further trial. This also was found to answer well, and to be superior to the ordinary cotton pyroxyline usually received from England. I have therefore indented for a full supply of it for next year. Some experiments were also made in preparing papyroxyline for ourselves, and at first with fair success, but in the hot weather the results were found to be very uncertain and not to be depended upon.

Processes.

8. Mr. Willis' platinotype process, mentioned in my report of last year, has been introduced instead of silver printing for subjects incapable of being photo-zincographed, when it is an object to have permanent prints. The process is exceedingly simple and satisfactory, but just now there is not much use for it. The sensitive paper has not been found to keep so well as was anticipated. This is owing to the damp climate, and if the paper is intended to be kept, it must be preserved in boxes with chloride of calcium or other dehydrating agent.

Platinotype process.

9. The simple pigment printing process, mentioned by me in last year's report as used at the Depôt de la Guerre, Paris, has been found of use in cases where only a few prints are required from a negative, and it is not considered worth while to make a transfer to zinc. The preparation of the paper used at the Depôt de la Guerre is a secret, but after a little experiment it was found that paper prepared as below gave very good results.

Pigment printing.

10. Four ounces of ordinary bazar glue are soaked in ten ounces of distilled water and dissolved by heat, the solution being clarified with the white of an egg.

Three packets of the dry native black ink, made at Lucknow, and known as *mustafi ink*, are soaked over-night in an ounce of distilled water and well stirred into uniform paste; two or three ounces of hot water are added, and the whole mixed well up with the warm clarified glue.

(It is desirable to use distilled water, and to add to it a small quantity of white Castille soap, about two grains, or a few drops of a strong alcoholic solution of this soap, to the pint, the water being just milky when filtered. This addition makes the coating of the paper more uniform. Ordinary water may be used, but more soap will be required if it is hard.)

11. The warm mixture of glue and ink having been well strained, bank post paper of medium thickness, or better Rives' photographic paper, previously damped, is coated as evenly as possible with it, by means of a 4-inch flat camel's hair brush, and allowed to dry in a horizontal position.

12. When required for use the coloured paper is sensitised by floating it, coloured side upwards, on a ten per cent. solution of bichromate of potash, and dried. The sensitive paper is exposed to light under a negative in the usual manner, but the exposure is rather long, varying from 8 to 15 minutes in the sun, according to the strength of color; the bank post paper requiring less exposure than the Rives'. After exposure the print is plunged into a dish of water at the ordinary temperature, which dissolves the colored glue in the parts unexposed to light, leaving the lines. The development is finished under a stream of water, weak parts being cleaned up with a sponger or soft brush. The prints are then transferred to a bath of alum and water, about three per cent. then rinsed in clean water, dried and trimmed. This process is only suitable for line work.

13. I have given a good deal of attention to this process during the year, with the help of the information gained on the subject in Europe last year, but I regret to say without much advance in the results previously obtained. In the early part of the year I tried preparing the pigment tissues by the formula given me at Vienna, but did not find it satisfactory for half-tone work. A series of trials was afterwards made of some tissues that Mr. J. R. Sawyar of the Autotype Company kindly, had specially, prepared for the purpose, but they were not found to work so satisfactorily as the ordinary tissues I was using last year. I therefore got out a supply of these same tissues, but they did not arrive till the rains, when, owing to the very dull weather and ill-health, I was unable to use them. When the weather changed in October,

Photo-electrotype.

I began again with these tissues, but found that though they had been carefully packed and kept dry during the rains, they had deteriorated a good deal, and did not give quite satisfactory results.

14. This difficulty of keeping the gelatine tissues during the rains has been experienced before, and seems to point to the necessity of our prepairing our own tissues as required. This is, however, a difficult operation in an Indian climate, and may require long and constant experiment to ascertain the most suitable kinds of gelatine and pigment to be employed to obtain the results aimed at. What is required is a tissue that will adhere well to the support on which it is developed, be perfectly soluble in the highest lights without being liable to lose the lighter shades; produce a relief with correct gradation in all parts of the image, and give the proper kind of grain when treated, after development, with an alcoholic solution of tannin, and this combination does not seem by any means easy to obtain.

15. I have also experienced a great many difficulties with the electrotyping, though the arrangements were similar to those I used last year with perfect success. This also is a matter in which knowledge and experience are required, and which it will take time to acquire.

16. If the process is to be worked successfully, it will be desirable for me to have an opportunity of working it out practically in Europe, where I shall be able to obtain skilled assistance and advice in overcoming the various difficulties to be met with, and have leisure to devote to it, free from the many interruptions of the ordinary office routine work. This opportunity I hope to have next year during my absence on furlough in Europe. The information I gained during my very short visit last year has been of use, and the hints given me by Mr. A. Dawson I have found most valuable as far as I have been able to work them out.

Zinc-printing.

17. It is worthy of record that the Lanham's patent rollers, made of Indian rubber, a few of which were sent out for trial by the Secretary of State on my recommendation, have been tried and found very superior to the ordinary rollers in keeping the work clean and clear on the zinc. They are also excellent for color printing, owing to the fine surface they have and the ease with which they can be cleaned. For collotype printing also they are very suitable. During the year a large number of sheets of the Indian Atlas have been printed in colors on zinc from transfers from the copper-plates. The zinc is found particularly well adapted for this kind of work.

18. About one-third of the work of the office during the year has been for other departments, as shown in detail in the accompanying table. The reproduction of maps, plans, and sketches connected with the campaign in Afghanistan for the Quarter-Master-General's Department is one of the principal items. For the Inspector-General of Military Works an extensive series of plans of forts and several standard plans of barracks, &c., have been reproduced. The charts for the Marine Survey Department and Port Office also form an important feature of this branch of our work. A good deal of work has also been done for the United Service Institution and for the Asiatic Society of Bengal. During the year I have gone very thoroughly into the question of charges for work done for other departments, and have made a scale for calculating the cost of such work, which I believe will meet all practical requirements.

Statement showing the Amount and Value of the work done for other Departments from 1st October 1878 to 30th September 1879.

Names of Departments.	Number of sections.	Number of negatives.	Number of pulls.	Number of complete copies.	Number of silver prints.	Number of platinum prints.	Price.	Remarks.
						*	Rs. A. P.	
Government of India, Foreign Department ...	1	4	54	15	...	...	86 0 0	
Ditto, Military Department ...	1	1	80	80	...	...	32 0 0	
Ditto, Public Works Department	1	1	50	50	...	...	29 0 0	
Government of Bengal	4	8	100	60	...	...	165 0 0	
Ditto of Punjab	2	8	360	225	...	...	218 0 0	
Ditto North-Western Provinces & Oudh, Public Works Department, Irrigation Branch	28	28	2,360	8,470	...	...	839 0 0	
Public Works Department, Railway	...	...	350	350	...	...	11 0 0	
Consulting Engineer, East Indian Railway ...	1	1	300	305	...	...	23 0 0	
Rajpootana State Railway	35	24	2,310	5,000	...	...	703 0 0	
Inspector-General of Military Works	63	147	7,828	8,624	...	...	4,577 0 0	
Quarter-Master-General	35	66	4,231	6,391	...	...	1,652 0 0	
Superintendent of Foundry and Shell Factory	1	1	12	12	...	...	29 0 0	
Executive Engineer, 3rd Calcutta Division ...	2	6	150	100	...	...	115 0 0	
Ditto ditto, Architectural and Building Division, Simla...	1	1	50	25	...		29 0 0	
Marine Survey Department	12	34	3,610	3,600	...	...	1,286 0 0	
Port Officer	6	19	710	710	...	...	374 0 0	
Meteorological Reporter	6	3	600	3,600	...	...	103 0 0	
Director-General of Telegraphs	6	6	100	50	...	...	57 0 0	
Telegraph Store Department	2	2	306	306	...	...	29 0 0	
Surgeon General, Indian Medical Department	1	1	50	50	...	...	16 0 0	
United Service Institution, Simla	6	7	6,360	8,200	...	...	987 0 0	
Presidency Volunteers	1	1	100	100	...	...	31 0 0	
Bangalore Rifle Volunteers...	...	...	6	6	...	...	1 0 0	Re-print.
Asiatic Society	18*	18	7,050	17,500	4	3	471 0 0	* Transfer.
Lieutenant G. H. Bartram	...	...	10	50	...	...	6 0 0	Re-print.
Total ...	232	387	37,077	63,834	4	3	11,850 0 0	
Cadastral, North-Western Provinces (photo-zincographs)	3,436	3,401	85,900	53,125	...	...	51,540 0 0	Twenty-five copies at Rs. 15.
Cadastral, North-Western Provinces (tracings)	690	...	17,250				4,830 0 0	Twenty-five copies at Rs. 7.
Cadastral, Bengal (tracings)	411	...	20,550	12,800	...	...	3,699 0 0	Fifty copies at Rs. 9.
Grand Total ...	4,769	3,788	1,60,777	1,32,759	4	3	71,919 0 0	

The above prices represent the full value of the work, including chemicals and materials received from England, share of superintendence and general charges, wear and tear of plant, &c.

(Sd.) J. WATERHOUSE, *Major*,

Assistant Surveyor-General,
In charge, Photographic Branch.

Extract from the Narrative Report, dated 16th January 1880, of J. B. N. HENNESSEY, ESQ., M.A., *Deputy Superintendent, 1st grade, in charge Head-Quarters Offices, Trigonometrical Branch, Dehra-Dun.*

COMPUTING BRANCH.

2. The following cost table of work done in the Computing Branch is similar to the corresponding tables exhibited in the reports for the past two years.

Calculating Branch.

Cost Table in Rupees, 1878-79.

CLASSES.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
1. Records, Library	160	70	62	31	72	72	75	44	73	73	97	86	5¼
2. Computations...	173	221	285	100	206	48	147	171	168	127	94	76	7
3. Accounts, returns, correspondence	401	352	303	370	339	231	296	444	418	469	495	536	18¼
4. Supply	58	45	18	61	111	97	95	49	25	60	87	32	3
5. Press copy	640	593	524	327	471	540	337	434	710	661	574	670	25¼
6. Press proofs	401	382	287	363	334	337	328	346	227	270	228	268	15
7. Charts	11	10	13	1	10	0	3	59	20	5	10	21	½
8. Stations	38	76	17	86	163	113	100	101	61	55	116	84	4
9. Leave, holiday	132	223	514	539	259	188	253	129	39	66	115	21	10
10. Meteorology, miscellaneous	165	220	171	314	227	440	406	272	249	332	224	246	13
	2,179	2,192	2,192	2,192	2,192	2,086	2,040	2,040	2,040	2,096	2,040	2,040	100

As pointed out in the last report, classes 2 and 5 are so intimately connected with one another that it is at times very difficult for a computer to distribute his work among them, and in general an increase or decrease in either of these two classes leads to a corresponding, but contrary, result in the other. On the whole, the percentages now given agree with those for the preceding two years, excepting in class 3, where the present numbers have risen to 18½, against 14 and 13 of previous years.

3. The particulars of the work, generally indicated in the preceding table, are given hereafter to such extent as appears desirable.

Calculating Branch. Particulars of work.

4. *Class* 2, *Computations*—

Principal Triangulation in general (in duplicate).

S. W. Q. and S. Trigon.	Reduction of compound figures, computed	2
	Table of weights (to be employed in final reduction of this triangulation) prepared	In part.
S. E. Q.	—Azimuths (astronomical) computed	1

Secondary Triangulation in general (in duplicate).

Chiefly N. E. Q. and Kumaun.	Traverses, computed	5
	Triangles, computed or adjusted	1,400
	Latitudes, longitudes, and azimuths, computed or corrected (single deductions)	1,350
	Heights, computed or corrected	300
Minor principal triangulation, Assam Valley and Kumaun.	Reduction of simple figures, computed	4
	Ditto quadrilateral, ditto	6
	Triangles, computed	72
	Latitudes, longitudes, and azimuths, computed (single deductions) ...	53
	Heights, corrected	54

In addition to the foregoing, the longitude of Murree was computed from six (experimental) sets of lunar zenith distances. For Colonel Ross, Political Agent, Bushire, six sets of time, six deductions of latitudes, and eight sets of longitudes from lunar zenith distances, and azimuth and length Shiraz-Ardakan were computed; besides various trial and verificatory computations made in order to trace (if possible) sources of discordance in certain results. Several determinations of latitude, longitude, and height were obtained from Major Biddulph's observations beyond Gilgit. Azimuth and length of 12 sides were determined for Captain Heaviside. Abstract of facts prepared to illustrate co-efficients of refraction on the N.-W. Himalaya and Kashmir Series. Calculations made of various kinds, for completion of volume II of the "Account of the Operations of the Great Trigonometrical Survey of India," &c., &c.

6. *Class* 4, *Supply.*—Data in manuscript have been supplied to 28 officers. This includes some unusually heavy work, *e.g.* instances:—for the Superintendent, Madras Revenue Surveys, transcribed 83 pages from Colonel Lambton's manuscript volumes, and prepared descriptions of all secondary and intersected points occurring on several charts of the Great Arc (section 8° to 13°) Series and East Coast Series. Computed and compiled data applied for by Colonel Anderson and Mr. Cooke of the Revenue Branch Survey of India, &c., &c. Also about 1,100 despatches were made of maps, forms, books and charts, the increase under this head being due in a great measure to the demand for maps of the country along our North-Western frontier, where our military columns were operating.

7. *Class* 5, *press copy.*—Prepared.

VOLUME II.—Table of contents and appendix No. 12, completed.

VOLUME V.—Table of errata.

VOLUME VI.—Tables, for incorporation in the introduction, to illustrate the Simultaneous Reduction.

N.-W. QUADRILATERAL, SYNOPTICAL VOLUME VII.—Orthography of proper names occurring in remaining part of the introduction examined; contents and errata tables revised; preface prepared.

S. E. QUADRILATERAL, BIDER AND BILASPUR SERIES.—Furnished with preface, contents, and errata tables. Also, preface prepared for the Calcutta Longitudinal Series.

S. W. QUADRILATERAL.—Working chart (for reduction of figure); alphabetical and numerical lists finished; descriptions of principal stations of all series except Singi compiled (need comparison); observed angles, sums of squares table and table showing *e. m. s.* of observation and graduation and reduction of figures finished for about ⅘ths of the quadrilateral.

SOUTHERN TRIGON, GREAT ARC SERIES, SECTION 12° to 18°.—Reduction of figures compiled (need comparison).

N. E. QUADRILATERAL,—BUDHON, AMUA, KARARA, GORA, HURILAONG, CHENDWAR, NORTH MALUNCHA AND NORTH PARESHNÁTH SERIES. Triangles; azimuth, co-ordinate and name lists (*compiled* in 1877-78), compared and revised where necessary.

DITTO. RANGIR, GURWANI, CALCUTTA MERIDIONAL, ASSAM, BRAHMAPUTRA, AND EASTERN FRONTIER SERIES.—Triangles, azimuth, co-ordinate, and name lists compiled and compared for all except Assam. East Calcutta Series, triangles and name list compiled and compared.

DITTO. GURWANI, HURILAONG, CHENDWAR, NORTH PARESHNÁTH, NORTH MALUNCHA, CALCUTTA, MERIDIONAL, EASTERN FRONTIER, AND CACHAR BRANCH SERIES.—Descriptions of principal stations, prepared.

In addition, the orthography of names occuring in Hundes' Report and in pamphlet of spirit-leveled heights, No. 1, Bombay Presidency (seasons 1874-75 to 1877-78), examined and rectified (by no means a light task). Also some progress made in compiling the preliminary lists of stations and stars required for the reduction and publication of all our observed latitudes.

8. *Class* 6, *press-proofs.*—This class is not susceptible of explanatory remarks.

That the duties were quite as laborious as they are important, is evidenced by the fact that they absorbed no less than 15 per cent. of our working power.

10. *Class* 8, *Stations.*—Of additional duplicate lists, one has been completed, making a total of 336 settled districts, accounting for 3,119 stations; also one new list and *six* duplicate or supplementary lists, descriptive of 27 stations, have been supplied to district officials; and the entire lists for British Burma have been checked and brought up to date for the Chief Commissioner.

11. *Class* 10, *Miscellaneous.*—Meteorological observations taken at Dehra twice daily on every day of the year, and at Mussoorie for six months. Supplied to Reporter to Government, North-Western Provinces, meteorological results for Dehra, and to Reporter to Government of India, Anemograms for both Dehra and Mussoorie, besides daily weather telegrams for Mussoorie. Tabular records of Mullah's last route translated from the vernacular, and a narrative account of his travels compiled; narratives of explorer L—'s route completed, and transcribed.

TYPOGRAPHIC BRANCH.

12. The work annually performed by this branch during the past five years is briefly given in the following table, where the unit (a page of foolscap) is the same throughout:—

	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
Pages composed	1,319*	1,179*	1,535*	2,050	1,844
„ printed	372,647*	319,000*	495,573*	630,894	590,043

* Averages for a twelve-month.

Photo-zincographing Branch.

13. The following are details of the work executed by this branch :—

MAPS.

Subject.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	.....	106	5,005
Afghanistan, 1st edition	October 1878 ...	2	4,396
Mysore and Coorg *(for Foreign Office)*	,, ,, ...	1	116
Kumaun and Garhwal *forest* map, sheet No. 21 } *(For Forest*	,, ,, ...	1	58
Ditto ditto 27 } *Department)*	,, ,, ...	1	55
Guzerat survey, sheet No. 31. section 2	,, ,, ...	1	86
Forest reserves in part of the North-Western Provinces *(for Forest Department)*	November ,, ...	1	809
Index to Cutch survey	,, ,, ...	1	104
Map to illustrate the Seistan arbitration *(for Foreign Office)* ...	,, ,, ...	1	86
Index to Guzerat survey	December ,, ...	1	495
Hyderabad, illustrative of the famine *(for Famine Commission)*	,, ,, ...	1	58
Index to Kattywar survey	,, ,, ...	1	522
Guzerat survey, sheet No. 28	January 1879 ...	1	172
Kattywar survey, do. 54	,, ,, ...	1	143
Ditto, do. 56	,, ,, ...	1	132
Kumaun and Garhwal survey, sheet No. 37	,, ,, ...	1	105
Jaunsar Bawar survey, sheet No. III	,, ,, ...	1	143
British Burma forest map, sheet No. 2 *(for Forest Department)*	,, ,, ...	1	237
British Burma forest map, sheet No. 4 *(for Forest Department)*	February ,, ...	1	229
Kumaun and Garhwal survey, sheet No. 29	,, ,, ...	1	110
Ditto forest map, sheet No. 22 *(for Forest Department)*	,, ,, ...	1	60
Turkestan, sheet No. 1, 4th edition	,, ,, ...	1	780
Kattywar survey, sheet No. 55-61	March ,, ...	1	131
Kumaun and Garhwal forest map, sheet No. 18 *(for Forest Department)*	,, ,, ...	1	62
Turkestan, sheet No. 3, 4th edition	,, ,, ...	1	796
Ditto do. 4, 4th do.	,, ,, ...	1	722
Guzerat survey, sheet No. 49, section 3	,, ,, ...	1	85
Ditto ditto 4	,, ,, ...	1	86
Jaunsar Bawar survey, sheet No. 4	,, ,, ...	1	143
Turkestan, sheet No. 2, 4th edition	April ,, ...	1	700
Guzerat survey, sheet No. 14	,, ,, ...	1	178
Kattywar survey, do. 49	May ,, ...	1	129
Kumaun and Garhwal forest map, sheet No. 16 } *(For Forest*	,, ,, ...	1	58
Ditto ditto 26 } *Department)*	,, ,, ...	1	41
British Burma forest map, sheet No. 1	,, ,, ...	1	254
Jaunsar Bawar survey, sheet No. 1	,, ,, ...	1	154
Ajmere and Merwara forest map *(for Forest Department)* ...	June ,, ...	1	444
Kumaun and Garhwal forest map, sheet No. 25 *(for Forest Department)*	,, ,, ...	1	72
Forest school circle, North-West Provinces *(for Forest Department)*	,, ,, ...	1	5
British Burma forest map, sheet No. 3 *(for Forest Department)*	,, ,, ...	1	246
Route reconnaissance by Captain T. H. Holdich, R.E. ...	,, ,, ...	5	580
Guzerat survey, sheet No. 32, section 1	July ,, ...	1	78
Kattywar survey, do. 40	,, ,, ...	1	154
Kumaun and Garhwal forest map, sheet No. 30 } *(For Forest*	,, ,, ...	1	55
Ditto ditto 31 } *Department)*	,, ,, ...	1	72
Portions of Western Hundes and Tihri Gharwal	,, ,, ..	1	109
Jaunsar Bawar survey, sheet No. 2	,, ,, ...	1	145
Afghanistan, 2nd edition	,, ,, ...	1	191
Mandakini-Alaknanda river (revised survey, 1878)	August ,, ...	1	108
Arghandab route map	,, ,, ...	3	333
Sketch map shewing march of Thal-Chotiali Field Force ...	,, ,, ...	2	70
Guzerat survey, Sheet No. 28, Section 1	September ,, ...	1	44
,, ,, 2	,, ,, ...	1	49
,, ,, 3	,, ,, ...	1	17
,, ,, 4	,, ,, ...	1	17
TOTAL ...	.....	168	20,229

Besides the foregoing, 1,394 blue-prints were issued, and 353 silver-prints (108 subjects) were prepared for the use of the engravers, for executive officers, and of sun-photographs for India Office.

CHARTS.

Subject.		When published.	No. of parts.	No. of copies printed.
East Coast Series, No. 2	Final	November 1878	1	363
,, ,, 1	,,	December ,,	1	375
Serial Chart of the Mountain Triangulation (for Synoptical Volume VII)	,	February 1879	1	401
Chart illustrating Pamphlet of Spirit-Leveled Heights, No. 3, Southern India	,,	,, ,,	1	500
Thayetmyo *vid* Prome towards Cape Negrais, and Pegu, Rangoon, and Coast Triangulation (secondary), season 1877-78	Numerical	May ,,	1	68
Madras Coast Series, season 1877-78	,,	July ,,	1	66
North Pareshnáth Series	Final	,, ,,	1	390
Southern Afghanistan Triangulation by Captain W. J. Heaviside, R.E.		August ,,	1	32
Chart illustrating Pamphlet of Spirit-Leveled Heights, No. 1, Bombay Presidency		September ,,	1	447
Total ...		.....	9	2,642

DIAGRAMS.

Subject.	When published.	No. of copies printed.
Polygons and other figures to illustrate figural reductions for volumes of the Great Trigonometrical Survey, Bench-Marks, &c., &c.	October 1878 ...	169
	November ,, ...	448
	December ,, ...	1,558
	February 1879 ...	330
	September ,, ...	107
Total ...	.....*	2,603
Professional and Office Forms, 1878-79 ...	.....	20,070

The total number of negatives taken is 962; the number of chromo-carbon prints, 1,294; and the number of transfers to zinc, 217.

Contrasting the work performed since 1874-75, we have—

Year.	Maps.	Blue-prints.	Silver-prints.	Charts.	Diagrams.	Forms.
1874-75	7,040*	20*	Not reckoned	3,015*	3,701*	24,219*
1875-76	14,025	12	126	1,678	9,722	18,314
1876-77	12,348	108	189	9,225	3,956	21,384
1877-78	12,481	195	426	4,531	4,877	23,736
1878-79	20,229	1,394	353	2,642	2,603	20,070

An abstract of the work executed during the past five years stands thus:—

Subject.	Number of Prints.				
	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
Maps, charts, and diagrams ...	13,756*	25,425	25,529	21,889	25,474
Blue-prints and silver-prints ...	Not reckoned	138	297	621	1,747
Forms	24,219*	18,314	21,384	23,736	20,070

* Averages for a twelve-month.

The services of this small office, which possesses but four printing presses, continue in great and general demand. Of Afghanistan and Turkestan maps alone no less than 8,568 sheets were "pulled" during the past year.

Drawing Branch.

14. The work performed in this branch is as follows :—

Description of Work.	No. of sheets or diagrams.		Scale one inch = miles	Remarks
	Finished.	In hand.		
Compilation.				
Map of Turkestan (4th edition, revised and enlarged) ...	4	.....	32	
Reduction chart of the north-east quadrilateral	.....	1	16	
Sheet No. 75 of spirit-leveled heights	.....	1	2	
Index to the Burma party secondary triangulation	1	.....	16	
Chart of spirit-leveling operations, seasons 1874-75 to 1877-78, to illustrate pamphlet of heights No. 1, Bombay Presidency ...	1	.....	12	
Index to the Cutch survey	1	.....	12	
Parts of Arabia and Persia for Colonel E. C. Ross, Political Resident, Persian Gulf, in extension of his map	8	2	12	
Map of country around Moré Pendulum Station for volume V of the account of the operations, &c.	1	.....	3½	For photo zincography.
Diagrams of figures of north-east quadrilateral for illustrating volumes of the operations of the Great Trigonometrical Survey	12	.....	6	
Map of Hundes from rough delineations by Mr. E. C. Ryall ...	1	.....	8	
Final Charts.				
Gora meridional series	1	.....	4	
Amua ditto	1	.....	4	
North Maluncha ditto	1	.....	4	
Rangir ditto	.....	1	4	
Budhon ditto	.....	1	4	
North Pareshnáth ditto	1	.....	4	

The miscellaneous work has been varied and very extensive, chiefly in consequence of our military operations in Afghanistan, but also in order that the maps of the Kumaon and Garhwal survey should be completed, and arrears of work by the latter stand disposed of. Further, a good deal of labor has been devoted towards collecting spirit-leveled data in the Punjab, which have been made available for use in this office through the kind co-operation of General H. W. Gulliver, R.E., Secretary to Government, and his officers; and it is hoped that this and other valuable information of the kind will be published ere long in continuation of the series of level charts originated by the Superintendent, Great Trigonometrical Survey.

Correspondence and Stores.

15. Unusual activity has prevailed in consequence of the great demands for surveying instruments and stores by the officers of the survey on service in Afghanistan. These demands were generally made at unavoidably short notice, and involved in many instances the adaptation of existing limited means to considerable wants—packing and despatching, finding suitable khalasies and clothing them, making advances of money on demand, and providing for the families of natives sent on service; thus the slender resources at my disposal have shared in the general strain on all departments to meet the wants of the public service.

As my former report on Mr. Meins's work was brought down to the end of 1878, it only remains to continue my statement to 30th March 1879, the day before his death. In this interval of 89 days, bad weather prevented any negatives being taken on—

1 day in January,
6 days in February,
3 days in March;

that is, on 10 days of 89, or on the average, 1 in 9. The period of minimum sun-spots was still prevailing, and spots or faculæ were obtained only to the following extent:—

	Faculæ and spots.	Spots only.	Faculæ only.
January	... 2 days.	0 days.	5 days.
February	... 0 „	0 „	4 „
March	... 0 „	0 „	11 „

where it will be seen that the prevailing feature was presented by faculæ alone. In all, Mr. Meins took 162 negatives and 63 "runs." The usual weekly despatches to the India Office of silver-prints and negatives were made with perfect regularity, and without accident.

Mean Velocity in Miles of the Winds which blew at Dehra-Dun during twelve months of 1878-79 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	1·43	3·66	2·50	3·32	3·61	3·29	3·87	3·26	1·77	0·77	·97	1·54
1 „ 2	1·14	3·03	2·33	3·00	2·82	2·52	3·43	2·74	1·23	·84	·93	1·39
2 „ 3	·86	2·79	2·29	2·80	3·07	2·48	3·43	2·39	1·53	·71	·83	1·18
3 „ 4	·75	2·69	2·00	3·00	2·43	2·19	2·67	1·94	1·07	·71	·73	·82
4 „ 5	·89	1·93	1·79	2·67	2·39	2·29	2·47	1·55	1·67	·45	·67	·64
5 „ 6	·79	2·07	1·71	2·33	2·39	2·06	2·57	1·77	1·17	·81	·90	·64
6 „ 7	·79	1·97	1·58	2·23	1·79	2·19	2·07	1·39	1·20	·61	·53	·50
7 „ 8	·25	1·72	1·58	2·00	1·64	1·61	1·90	1·23	1·60	1·19	·73	·29
8 „ 9	·29	1·72	·96	1·70	1·61	2·00	2·00	2·03	2·43	1·29	·77	·68
9 „ 10	·67	1·45	1·25	1·40	1·71	2·29	2·40	2·61	2·17	1·58	1·00	1·00
10 „ 11	·89	2·34	2·21	2·00	2·36	2·32	3·20	3·74	2·87	1·61	1·60	1·18
11 „ 12	1·30	2·52	2·33	2·23	2·79	3·26	4·13	4·42	3·23	2·32	1·77	2·00
12 „ 13	1·33	3·38	2·96	3·42	3·32	3·87	5·17	5·19	3·86	2·61	2·50	2·19
13 „ 14	1·21	2·90	2·70	2·87	3·43	3·97	5·20	5·10	3·69	1·87	2·45	2·07
14 „ 15	1·57	3·14	2·42	3·13	3·54	4·52	5·00	5·06	3·66	2·48	2·48	2·04
15 „ 16	1·00	2·41	1·83	2·84	3·04	4·45	5·40	5·03	3·70	1·90	2·00	1·64
16 „ 17	·29	1·41	1·00	2·10	2·89	4·35	4·13	5·10	3·77	1·61	1·53	1·39
17 „ 18	·21	1·14	·46	·55	1·86	3·23	3·80	4·45	3·83	1·52	·87	·96
18 „ 19	·86	2·38	1·21	1·29	1·14	1·39	1·97	2·19	2·93	·08	·30	·75
19 „ 20	1·61	3·79	1·75	2·42	1·79	1·42	2·00	1·26	1·37	·52	·63	1·32
20 „ 21	1·71	4·24	2·33	3·48	2·86	1·87	2·83	2·65	1·27	·61	·80	1·68
21 „ 22	1·71	3·93	2·50	3·13	2·96	2·58	3·40	2·58	1·67	·52	·77	1·43
22 „ 23	1·89	4·34	2·71	3·58	3·36	2·87	3·67	3·19	1·57	·68	·60	1·54
23 „ 24	1·89	4·10	2·58	3·23	3·46	3·13	3·93	3·29	1·63	1·03	·70	1·61
Sums ...	25·33	65·05	46·98	60·72	62·26	66·15	80·64	74·16	54·89	28·92	27·06	30·48
Average ...	1·06	2·71	1·96	2·53	2·59	2·76	3·36	3·09	2·29	1·21	1·13	1·27

Monthly Meteorological Results taken from the Register kept at the Head-Quarters Office, Trigonometrical Branch, Survey of India, Dehra-Dun.

Year and Month.	Barometer.						Hygrometer.				Thermometer.								Rain.		Wind.	Cloud.	
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.		At 3-30 P.M.		Dry Bulb.					Wet Bulb.							
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.	Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum wet.	Minimum wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
1878.																							
October ...	27·746	27·565	27·651	27 648	27·461	27·564	60·6	·623	60·8	·490	104·5	52·0	88·7	55·0	73·3	76·6	48·7	63·1	1	·17	N.	...	1
November ...	·855	·641	·752	·758	·471	·658	47·9	·560	51·6	·439	95·4	40·0	82·0	45·5	64·5	66·5	40·2	53·1	...	.....	N.	...	...
December ...	·885	·648	·784	·821	·590	·702	42·3	·624	42·6	·407	89·7	32·5	76·0	36·5	57·0	63·0	33·5	48·0	2	·22	E.	1	1
1879.																							
January ...	·913	·697	·794	·801	·630	·711	42·0	·629	42·1	·398	87·5	35·6	73·6	39·8	57·0	57·5	35·7	47·2	1	·10	S.W.	2	3
February ...	·837	·605	·736	·758	·538	·655	42·8	·577	41·6	·381	89·2	37·9	77·3	42·1	60·4	61 6	36·2	49·1	4	1·47	N.	4	4
March ...	·809	·560	·681	·705	·470	·602	49·7	·556	45·4	·337	104·1	42·7	91·1	46·2	66·7	77·2	38·8	54·7	6	2·46	W.N.W.	3	4
April ...	·693	·465	·582	·597	·392	·495	51·7	·352	48·9	·234	112·8	...	101·2	52·5	79 5	70·7	46·3	59·6	1	·25	N.	2	2
May ...	·633	·351	·493	·507	·274	·402	62·1	·402	60·0	·290	124·3	60·0	106·7	66·5	87·2	79·7	51·0	63·8	...	.....	W.S.W.	1	3
June ...	·529	·281	·399	·481	·189	·323	71·9	·660	73·7	·610	120·8	56·6	105·5	62·0	84·0	84·1	58·9	74 1	15	13·36	W.N.W.	5	5
July ...	·522	·262	·391	·481	·242	·327	75·6	·890	77·2	·835	108 7	69·0	89·9	70·3	79·7	83·2	68·7	76·0	26	36·23	S.S.E.	9	9
August ...	·587	·306	·450	·482	·239	·377	74·8	·887	76·2	·864	107·4	69·0	88·2	70·6	78 7	81·2	68 3	74·9	29	34·98	S.S.W.	9	8
September .	·677	·389	·526	·596	·329	·412	72·1	·807	73·4	7·19	108·0	61·7	88 5	66·4	77·9	80·2	62·3	72 9	14	18·47	N.	4	5

Note.—The height of the barometer cistern above mean sea-level at Karachi is 2,232·41 feet

REPORTS

ON

TRANS-HIMALAYAN EXPLORATIONS.

BY G___M___N IN 1878-79,

BY L___ IN 1875-76,

AND BY THE MULLAH IN 1878.

To accompany the General Report of the Operations of the Survey of India for 1878-79.

Report by Lieut. H. J. Harman, R.E., Assist. Supdt., Survey of India, on the exploration, during 1878, in Eastern Thibet, of "G—m—n."

In June 1878 I engaged G—m—n to give me instruction in the Thibetan language. He is a married man and a lama of the Pemiongchi monastery in Sikhim; he is a Sikhim Bhotea and is about 30 years of age—a good Hindustani scholar, said to be well read in his own language and Thibetan literature, has a smattering of English, understands English figures and simple accounts; has been employed as a Sirdar (head of a gang of coolies) in the Public Works Department and casually as Interpreter at the Court of Darjeeling; he has also travelled a little in the plains of India.

Finding that my studies seriously cut into my time, I gave up reading and took to teaching G—m—n a little surveying, he took to it very well, and as I found him to be very sharp and industrious, I gave him the offer of service as an explorer which he eagerly accepted. He soon learnt traversing with the Prismatic Compass, to plot his work, use the Boiling Point Thermometer, read a Hadley's Sextant, and understand maps. The rainy season of 1878 was very wet, and during 27 consecutive days G—m—n did not get a sight of the sun or stars.

2. I decided it was better for him to go to work with his imperfect knowledge than to lose a season. He was instructed to trace the Sanpo river from Chetang downwards as far as he was able. Also to make a circuit of the Yamdok Cho lake and give a good description of the iron chain bridge over the Sanpo river at Chaksamchori.

On the 6th of August 1878, he left Darjeeling and travelled by the Jelep pass to Phari and thence by the Yamdok Cho lake and the iron chain bridge to Lhasa. He did not make the circuit of the Yamdok Cho, but made some observations which will be found in para. 8. He gave an account of the bridge, which will be found in para. 9.

He spent considerable time at Lhasa and in the monasteries thereabouts, and spent a round sum in presents to high Lamas, in purchase of butter for burning at shrines, &c.

He went to Debung monastery and found it contained 9,800 Lamas, so that it has become the largest monastery in Thibet. He saw the great copper caldrons in which rice and tea are prepared for the Lamas; caldrons measuring 20 feet across and 6 feet deep, built up in masonry and with planks laid across, so that the cooks might easily stir up the contents and ladle them out.

He paid a visit to the Bell foundry and saw some large bells 2 feet high; very little work was going on.

He states that the rice from Bhutan, which is considered the best, is not allowed to be sold in the Bazaars to the general public but can only be sold to Lamas. Nepal rice is sold to the public, and is dearer than rice sold at Darjeeling, and the commonest kind of butter is very expensive.

He was very little troubled by rain, leaving it behind him at Phari, and getting it only at Rip village and Mimjong. Some snow fell at Chukorgye monastery and the Lungla pass, and the country between the monastery and the Cholamo lake was covered with snow. Near Rip village he entered an undulating country covered with low thorn bushes, so low that he could see about him in every direction but quite obscuring his line of route. From fear of robbers and of not turning out much work, he hurried over this piece of his route at undue speed, and some 8 or 9 of his bearings have had to be changed that his work might plot. He also kept the record on pieces of paper and did not make daily entries in his Field Book from these scraps of paper, according to the strict orders he received, but I have very carefully questioned him about this portion of the route and think it sufficiently trustworthy for geographical purposes.

His altitudes of the sun are very doubtful and his dates are wrong; as yet I have not been able to make any thing of the astronomical work.

He took very few Boiling Point observations, but they may be relied on; his value for Chetang agrees well with Nain Sing's determination. Altogether he did not do the amount of survey I expected from him, and on his return in January 1879 I dismissed him. His persistent declarations that he had done his best, distress at being sent adrift, and the probabilities of his traverse being correct from its fulfilment of the conditions required by D'Anville's map, and affording from its course the drainage areas which by recent discharge measurements of the rivers of Assam are required, led me to take the man on again and send him to Pundit Nain Sing at Almora for proper instruction in the use of the Sextant and his Survey duties. He prosecuted his studies with vigor and has gone away on a most important journey, guided by a Lama who has traversed the whole route G—m—n has to follow.

3. Starting work at Chetang in October 1878, he followed down the right bank of the river for 1¾ miles and then crossed by boat to the left or N. bank of the river to the monastery of Ngáritasong (300 Lamas), fort of Takurjong and village of 40 houses. The Sanpo river at point of crossing flows in a wide sandy bed and the breadth of water is about

400 paces. For a distance of 100 paces the boat had to be rowed, the remainder of the passage was made by poling with poles 25 feet long; the current was very slight. The discharge of the river at the most moderate estimate would give on the above data about 15,000 cubic feet per second, which accords well with what would be deduced from Nain Sing's report.

At 10 miles from Chetang is the village of Jamtong (80 houses) where a road comes in from Lhasa: it is a road for the Giaour Rimboche to travel to the small monastery of Densuti, which is 4 miles to north of G—m—n's route. The road is defined by two parallel rows of stones placed close together, marking the limits of the road.

At 14 miles from Chetang the route ascends for half a mile and the monastery of Chakurjong comes into sight: I would identify the name of this monastery with the name of the small river marked "Tchiacar" on D'Anville's map.

At 18½ miles from Chetang are the remains of a large fort and the small monastery of Sangri: I would identify the monastery with the "Sancri" of D'Anville's map.

At 30 miles from Chetang the route leaves the Sanpo and goes to the north.

At 40½ miles there strikes in a road from Lhasa, prepared for the Giaour Rimboche to pass along. About 2 miles further on, the Mik Chu stream (which rises in the Lungla pass) is crossed: I think this may be the small river marked on D'Anville's map.

At 44 miles, he met 300 Lamas returning to Ngáritasong monastery from a trip to the Chukorgye monastery.

At 54 miles he crossed the Lungla pass, the rise up to which was very gradual. The pass is high and there was snow lying all about. A moderate descent over 5½ miles took him to the Chukorgye monastery which contains 300 Lamas. Here he stayed and took a trip to the small lake of Cholamo, which is situated on very high ground about 8 miles from Chukorgye. Into this lake it is customary to throw rupees and white silk scarves. To the Giaour Rimboche this lake is of importance, for he can by looking into it foretell his death and new birth.

The large and fine fort of Gyatsa Jong and the Thakpo monastery are met with at 88 miles from Chetang: 2 miles further on, the route again meets the left bank of the Sanpo river. Just across the river is the meeting of 3 roads, one from Chetang, one to Tsári 7 days' journey, and a route to the Khombo district. Tala monastery is seen to north of the route at 101½ miles from Chetang, and the Tala Chu stream is crossed by a bridge 26 paces long. All the bridges over the streams are of the same pattern: the abutments are of stone and the chasm is spanned by beams one above the other, each one overlapping the one below till but a small gap remains in the middle which is covered by planks; the shore ends of the beams are weighted down with stones.

At 105½ miles is the small monastery of Paruchude where the Giaour Rimboche (a boy of 1½ years of age, and seen by G—m—n) was born. 150 Lamas have recently taken up their residence at Paruchude.

At 111 miles is Aru monastery of 60 Lamas and close by is a village of 21 houses.

A mile beyond Aru, he met with 5 Chinese journeying to Lhasa with loads of musk balls which they had collected in the Lepcha district to south of and near Tsári. Across the Sanpo is a road going south to the country where lead mines are worked: the district is 4 days off: it supplies Lhasa and all the surrounding country with lead; the people pay their revenue in lead.

At 120 miles, he again crossed the Sanpo to its right bank. The water has a breadth of about 250 paces, has a very slight current and is apparently very deep.

He now journeyed by the right bank of the river all the way to Gyala Sindong which is at 287 miles from Chetang. There are many ups and downs along the route, but the river is kept in sight nearly all the way.

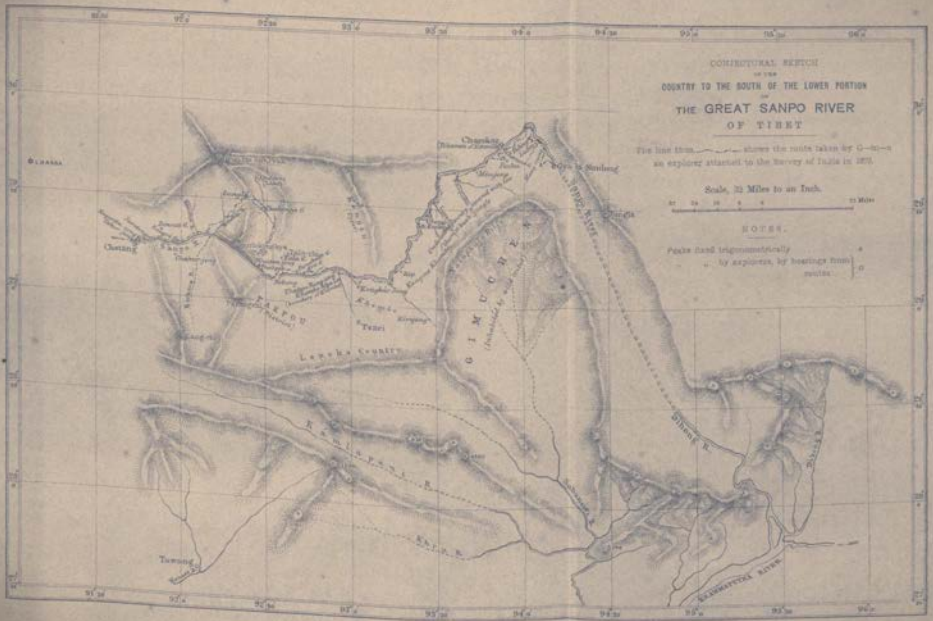
At 123 miles is the large monastery of Thakpo Nongjong, the name of which I would identify with the name of the district "Taepou y" on D'Anville's map.

At 125 miles he crossed the Tsári Chu river which comes straight from Tsári only 2 days off to the south. I take Tsári to be the "Chai" of D'Anville. It is said to be not a large town, but there are many villages in its vicinity and plenty of bamboos and wood. 1½ days to south of Tsári is a country of wild tribes: the district is called Gimuchen, literally the "naked man country".

There is a rise of 5 miles on to the ridge called the Khombo-nga-la which forms the western boundary of the Khombo district and which I take to be the "Cone Pou y" of D'Anville. Khombo is the general name for Eastern Thibet. At 140 miles is the small monastery Kongkár Jong and a ruined fort.

On the 23rd October the Kimdong Chu river was crossed, it is rather large and flows in a wide bed. The bridge had been washed away, and the river being full the crossing was a matter of great difficulty and danger. 2 days' journey up this river is the town of Kimjong, distant 3 days from Tsári. Near the river is a low stone wall to mark the boundary between Kongtu (upper) and Kongme (lower) Khombo. At this place the Sanpo makes a great bend and turns to the north-east for a course of nearly a hundred miles.

At 171 miles the route enters an undulating country covered with low scrub, thorn



Lithographed at the Surveyor General's Office, Calcutta, January 1881

jungle: habitations are very scarce.

At 188½ miles he came to the large forts of Orong and Kacha whose Jongs (governors) were in charge of the adjacent tracts of country. Here he met many people whom he calls Lepchas. They are called Membo by the Thibetans, who give the same name to the Lepchas of Sikhim. In face, complexion and dress they are not distinguishable from the Sikhim Lepchas, but they do not speak the Rong language (that of the Sikhim Lepchas) but have a language of their own: an interpreter is kept for them at Orong. They pay tribute to Thibet, and are much esteemed for their truthfulness and straight forward dealing. They had come down the Lung Chu river, and said their country was 9 days' journey off and that it marches with Gimuchen the country of savages. They said they had many villages near the line of route from Chetang to Táwáng and Odálguri in Assam; a route traversed by Nain Sing and the explorer L—.

They call themselves Pakchátsiríba and I would draw attention to the Dsiri mountains and the town of "Dsiri" marked on D'Anville's map to the west of Tsári. A good number of men had come to Orong for trade and had brought with them valuable loads of musk balls, madder, pepper, and 'láshin', also numbers of cane and bamboo baskets of the fashion of the Sikhim kilta or tapa, which is a basket resting on the back and held by a strap across the forehead. Nearly all the musk which is found at Lhasa comes from the Lepcha district, which also supplies most of the baskets found about Lhasa.

At 212 miles, across the Sanpo, is a road to Lhasa, said to be only 9 days' journey off, though there are 2 high ridges to cross. This is a most important statement, as it corroborates the accuracy of the survey up to this point.

At 215 miles he crossed the Naiupu Chu, a large river flowing in a sandy bed 500 paces wide. A short distance from the Sanpo it splits into three streams. Formerly the route used to cross these three streams but the bridges have been washed away.

The river takes its rise in the Naiuphula *hills* which are far away, but visible, to the south.

At Mimjong he stayed 2 days to question the savages who had come there for trade. They had come down the Naiupu Chu river and said their homes were 2 days' journey to south of the Naiuphula range. They are the people of Gimuchen. Madder, durry cloths and much Indian corn were brought for exchange with wool and iron. They would not receive cash payment. Occasionally, children and short witted men are brought for sale as slaves; for a woman they would get the equivalent of 60 Rupees. The practice of selling slaves is common among the Miris of the Subansiri valley. To G—m—n I showed some photographs of Hill Miris, and he affected to recognise a resemblance between them and the savages he met at Mimjong, also the long swords and plaited cane waist belts. At 226 miles is the village of Khomboding on the eastern boundary of the Khombo district.

An ascent of 6 miles takes one to the small village of Fuchu.

At 242½ miles is the important monastery of Chamna (500 Lamas). Across the river, on the left bank, is the monastery of Chamkar (400 Lamas), with villages in its neighbourhood and a road to Lhasa. I take this monastery to be the "Tchamca" of D'Anville, on account of the great bend in the river to the south which both G—m—n and D'Anville place just below "Tchamca." Before reaching Gyala Sindong, which is a large fort at 287 miles from Chetang, the ruins of many villages and forts were passed. At Gyala Sindong the snowy peak of Jungla bore 130°, the river passing through a gorge to west of it. G—m—n closed work at Gyala Sindong. The road continues on along the right bank of the river for 4 days and then crosses to the Poba or Lhoba country. The word "Poba" signifies a man of Bhutan, also independent. The country is peopled with all the outcast rogues and black sheep of Thibet; the inhabitants proper have a peculiar dialect and differ greatly from the Thibetans in costume and religious observances. They are bordered to the south by a country of savage tribes known as the Gimuchen country.

There is a road from Gyala Sindong into the Pemakou district, which is subject to Thibet. In it are many villages of Lepchas and people of Bhutan. I think this Pemakou may be the "Kenpou" of D'Anville. To Gyala Sindong G—m—n gives the height of 8,000 feet, so that the river has fallen 2,000 feet in its 250 miles of course from Chetang; most of the fall may occur in the unexplored bit of the river, beginning at 30 miles east of Chetang.

4. If the Sanpo be the Dihang branch of the Brahmaputra, then it has a fall of about 7,000 feet in about 160 miles, or 40 feet per mile, which is not a very great fall for Himalayan rivers.

G—m—n was told, that report had it, the river after flowing through the Gimuchen country entered a land ruled by the British. The Dihang river has at its mouth a discharge, at minimum level of the year, of 55,000 cubic feet per second, or 4 times that of the Subansiri river, and twice that of the Brahmakund branch of the Brahmaputra river. The wild tribes called "Abars" who live in the Dihang valley, trade with Assam and Thibet; the more wealthy among them wear Thibetan woollens. They say their river comes from the far north west, and our survey operations in Assam have shown there is a great gap in the snowy ranges through which the Dihang passes, and that thereabouts (to N. W. of the mouth of the Dihang) is much low lying country.

G—m—n states, that from Gyatsa Jong to Gyala Sindong the river is of very variable width and is in places very narrow; at Gyala Sindong it is but 150 paces wide though deep

and with moderate current. The flat and sandy nature of the bed in this part of its course may cause considerable filtration and G—m—n may not have noticed the places where it flows in more channels than one.

According to D'Anville's map, the Sanpo flows into the Subansiri, but according to G—m—n's exploration this can hardly be, the river would have to turn back on to itself and after draining a large tract of country and the very rainy district of the Miri Hills to north of latitude 28°, appear in latitude 28° with a discharge of but 9,000 cubic feet per second at minimum level of the year. Very agreeable results are found by turning it into the Dihang.

5. In the construction of my map I have considered that 2,000 paces cover one mile of route. The route traverses 2½° of longitude and there are many ups and downs along it, so that I think it would not be unfair to make some reduction in the longitudinal distance traversed and plot the fort of Gyala Sindong in longitude 94°. This adjustment would give the Sanpo below Gyala Sindong a more easterly course.

7. G—m—n returned to Darjeeling by the routes marked in the neighbourhood of latitude 30°: I have obtained from him very little information concerning them.

On his way back through Phari he found encamped there a large number of Thibetan soldiers, not less than 200: it was rumoured that 500 more soldiers were on their way to Phari from Shigatze, Giangze and Lhasa. One day when near Singlo monastery he met about 500 soldiers, mostly Chinese, on their way to re-inforce Lhasa; they were all mounted on ponies and travelling anyhow, singly and in groups: they had no arms with them. The demonstration at Phari had for its object the causing the Deb Rája of Bhutan to make some reparation for a number of excesses recently committed by his people in the Chumbi valley and elsewhere. I have been told the demonstration had the desired effect and the soldiers did not need to go to Tasisudon (the capital of Bhutan) as was thought might be necessary.

G—m—n describes Phari as a most desolate place, without any wood, situated in the midst of a vast plain, at 12,000 feet above sea level. The ascents and descents from Phari to Lhasa are very gradual and the route is extremely easy, an account which agrees with the statements of other explorers and the traveller Turner.

8. About the Yamdok Cho lake I had written in my report on the journey made by the explorer L—. in 1875. "It is at least 2 miles wide at Yárchi (Yasi) and half a mile at "Demálung. The lake has no outlet yet the water is sweet and good. The eastern margin "of the western part of the lake borders a stretch of flat land from which rises a mass of "mountains culminating in a rounded peak called Tungchin, which is about 2,000 feet above "the lake. On the slopes of the mountain, herds of yak and sheep were grazing, and several "houses were seen in one of the valleys. The water of the lake does not surround the "Tungchin mountain making it an island as is represented on our maps, but the mass is "connected with the mainland by a wide isthmus covered with boulders, at about 10 miles "S.E. of Yasi."

The Yamdok Cho is the famous ring lake of "Palti" shown on D'Anville's map. Mr. Manning saw it in 1811, but did not know it was in the form of a ring. He said the water was very bad whereas Pundit Nain Sing, C.I.E., who visited it in 1866, reported the water to be perfectly fresh, and he also obtained the additional information that the lake had no outlet and it required 18 days to make the circuit of it. Starting from Nangaeche Jong Tarjum (near the S.W. corner of the lake) G—m—n soon struck the lake and going along the western margin he journeyed northwards for 2 miles and noticed the water rapidly decreased in width. There he found it but 400 paces wide and the lake broken through by a gap at least a mile wide, covered with boulder stones: the general level of this causeway was raised but little above the level of the water of the lake.

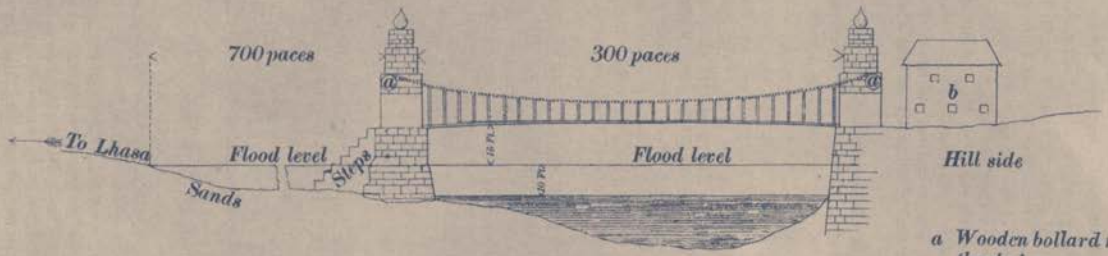
G—m—n describes the lake, between this break and the Khamba la pass, as a chain of lakes, the connecting links being often very narrow. He was told by a man who had made the circuit of the lake for "neko" (that is, the making a journey for cleansing from sin and sloth) that the circuit of the lake took 15 days, the eastern part of the lake was wide and the marches there were difficult. Thus the lake may be put down as having a circumference of 100 miles. The explorer L—. saw the lake in December 1875, G—m—n saw it in September 1878.

9. The great iron chain bridge over the Sanpo river, between the Yamdok Cho and Lhasa, is of the following construction.

The bridge is called Cházumtuka, the small monastery at south entrance to the bridge is called Cházumchori; in former accounts this has been written Chaksamchori.

The bridge is formed of 4 iron chains, 2 on each side. From the chains are suspenders of rope, carrying the footway which only allows of one passenger crossing at a time. During the rains the bridge is not in use on account of its northern end being separated from the shore by a wide stretch of water; then the river is crossed in boats. No toll is taken: the neighbouring villages support the monastery and maintain the bridge as payment of their revenue. The chains are stretched very tight and are fastened off by wrapping round huge bollards of wood built into the masonry of the piers. The width between the piers is 300 paces. The chains are formed of loops of iron a foot long, the diameter of the iron rod forming the loops is only one inch. G—m—n could obtain no history of the bridge; he thought it the most wonderful structure he had ever seen.

IRON CHAIN BRIDGE OF CHAZUMTUKA

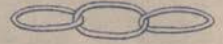


a *Wooden bollard round which the chains are wrapped*

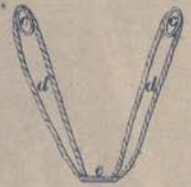
b *Chazumchori Monastery*

Links of Chains

<1 Foot>



Transverse Section of Bridge



c *Iron Chains*

d *Rope Suspenders*

e *Footway*

RANJIT SINGH, PHOTO.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, August 1879

G. G. OLLENBACH, ZINCO.

Report on Trans-Himalayan Explorations in South-Eastern Tibet, in 1875-76.

1. In March 1875 the explorer L—started from Darjeeling and carried a route survey through Sikkim *vid* the Tibetan frontier out-post of Gánpá Jong to Shigatze. From Shigatze he proceeded eastward along the banks of the Sángpo or great river of Tibet, for about 50 miles, thence to the Yámdochho Lake, leaving which he reached the river again and traced its course down to Chetáng. From here he turned southward and endeavored to penetrate into Assam, but his progress was stopped at Mautángong (Tawáng) and he was compelled to return to Shigatze. Starting again from Shigatze he proceeded to Giángche Jong, and travelling thence *vid* Kálápángá, Phárí, and Chhumbí (the summer residence of the Sikkim Rájá) he crossed the Jílíph Lá and returned to Darjeeling in July 1876.

2. His route survey was carried on by the usual methods of compass bearings and pacing, and was the first work of the kind ever undertaken by him independently. His instrumental equipment comprised a box-sextant, a watch, two pocket compasses, two boiling and two ordinary thermometers; of these on the present occasion he only used a compass, and the boiling thermometers for the approximate determination of heights.

3. The first part of his work from Darjeeling to Thángú, a village some 16 miles south of the Sikkim frontier, was over ground which had been traversed by Dr. Hooker in 1848-49; a map of Independent Sikkim by the latter* shows all the country through which explorer L—travelled as far as the Kángrá-lámá Lá or Lásính pass. Thus there was a good check on this portion of L—'s work. The positions of Shigatze, Giángche Jong and Chetáng had been fixed by former explorations, and the routes followed by L—from Shigatze to Giánche Jong, and from Chetáng to Tawáng were the same as those traversed by the now well known Pundit Nain Sing in 1865 and 1874. Hence there were considerable portions of L—'s work which could be tested against explorations formerly made by a thoroughly experienced and reliable man, and thus a fair idea obtained by inference of the correctness of such portions of his work as had no intermediate checks.

4. Shortly after crossing the Kángrá-lámá Lá into Tibetan territory and when he had arrived within some 3 miles of Gánpá Jong, the explorer was taken prisoner by a party of horsemen and carried into the fort for examination into his business, destination, &c., by the Jong or Governor, who confined him in a house outside the fort, under a guard and detained him for about 15 days. Though not subjected to actual violence he was threatened and otherwise treated so as to cause him no little anxiety. Eventually he was sent on to Shigatze, where he was again questioned by the Governor, and at first told to present himself for his dismissal in 3 days time; but owing to the suspicions of one of his guard from Gánpá Jong it was subsequently determined to detain him until the arrival of a party of merchants who were shortly expected. He was compelled to remain in Shigatze altogether over five months, having a certain amount of liberty in wandering about the city and its environs, which he utilized by collecting information regarding the place, and the great monastery of Táshílumbo; but he was too narrowly watched to succeed in escaping as he wished to do. Finally, on the arrival of the expected merchants at the end of October, he contrived to secure their support, and so was allowed to proceed eastward.

5. Leaving Shigatze in November 1875, he travelled along the banks of the Sángpo River for about 50 miles to Jagsá, between which place and the iron bridge over the river on the road to Lhásá at Chakh-jamchhurí there is said to be no road along the river bank, the river in this part of its course passing through rugged hilly country and falling over many rapids. From Jagsá he turned south-east, and then eastward again to Yásí on the Yámdochho Lake. With regard to this lake, L—contradicts the hitherto accepted statement that it is a complete ring or circle of water surrounding the Tungchín Mountain; he states that this apparent island is connected with the mainland by a broad causeway, and that he saw flocks and herds grazing on the slopes of the mountain, and some houses in a valley. This statement is confirmed by a more recent explorer who visited the lake in 1878, and who, travelling along its margin, saw the connecting link, a broad isthmus covered with boulders, which he places some 10 miles S.E. of Yásí.

6. From the lake, L—turned northwards again to the river Sángpo, and followed its right bank down to Chetáng, where he remained some little time. Being warned that any further progress down the banks of the Sángpo, unless in company with a strong body of men, would be attended with considerable danger from robbers and from the wild tribes along the route, he turned southward *vid* Karkang with the intention of penetrating into Assam, through Tawáng, over the route taken by Pundit Nain Sing in 1874-75. On reaching Tawáng however he was seized and carried before the authorities, who refused to allow him to proceed any further southwards, and confined him for a month in the public flour-mill at Kiá-ká-rong, some 2 miles north of Tawáng; the only attempt he made at negotiating his own release being punished by the infliction of a fine. Eventually a mounted guard

* In Volume I, Hooker's Himalayan Journals.

was told off to escort him to Lhásá; but fortunately some informality in the documents carried by the guard induced an intermediate official, through whose hands he passed *en route*, to release him. Though thus set at liberty he despaired of success in any further attempt to reach Assam, and so made the best of his way back to Shigatze.

7. About the end of March 1876, the explorer succeeded in making arrangements at Shigatze to return to Darjeeling *viâ* Giángche Jong and Phárí, to which latter place Captain Turner had travelled from Shigatze in 1783. He travelled in company with a party of merchants, and with the exception of men occasionally boldly demanding alms from them, they were unmolested till they reached Phárí. Here however the explorer seems again to have fallen under suspicion; he was detained for a month, and probably matters would have gone very hard with him but for the kindly interference on his behalf of one of the leading men of the village, who obtained his release from the Chinese officials. From Phárí he made his way across the Jílíph Lá and reached the cart road from Darjeeling at Lindam. Travelling along this road he found the Commissioner of Darjeeling in camp at Kálingpung, and reported himself to him in July 1876, having been absent on his journey sixteen months.

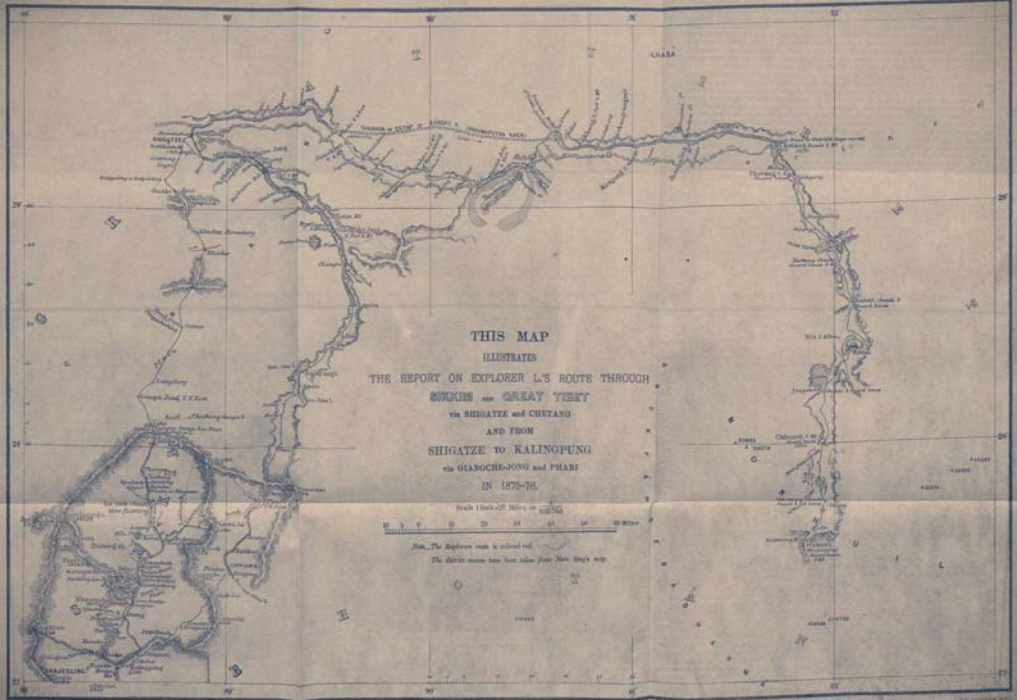
8. Such portions of his work as could be compared against former explorations, proved fair, and the new ground traversed between Shigatze and Chetáng, plotted between the positions of those two places as formerly determined, proved satisfactory. But on fitting in his route from Darjeeling to Shigatze on the known positions of those two places, sensible discrepancies appeared in the positions of points common to his work and Dr. Hooker's, which were difficult to reconcile. As the explorer had traversed the northern portion of this route, from Gánpá Jong to Shigatze, under the surveillance of a guard, it appeared probable that he could not have been able to take his bearings and count his paces with much care or exactitude, and hence it was suspected that the major portion of the error, apparent in his route from Darjeeling to Shigatze, would be found to lie between Gánpá Jong and Shigatze. However, as he could not with safety revisit the neighborhood of Gánpá Jong, it was considered expedient to send him out again as far north as the Kángrá-lámá Lá, over the portion of his work common to himself and Dr. Hooker, to observe the latitudes of certain obligatory points, and to connect these points by short route surveys with the nearest hill tops whence bearings could be taken to trigonometrically fixed peaks.

9. Accordingly he left Darjeeling again on the 29th September 1877 with a pocket compass, a prismatic compass, and a 6-inch sextant; but on account of clouds and bad weather he was unable to take the preliminary bearings he had been instructed to observe until the 27th October. He then proceeded on his way to the Kángra-lámá Lá, observing for latitude at five points of his former route, and connecting two of these latitude stations by short route surveys with adjacent hill tops whence he took bearings to known peaks. He failed in connecting the other latitude stations by bearings in this manner with trigonometrically fixed peaks, owing to clouds and bad weather. The results of these observations satisfactorily demonstrated that the errors in his former route from Darjeeling to Shigatze lay chiefly in the portion north of Gánpá Jong, as had been suspected; and on replotting his work on the basis of his latitude observations, the points common to himself and Dr. Hooker agreed very fairly.

10. The explorer notes a strange and apparently unaccountable phenomenon connected with the Giamchana Lake. At intervals of from five to ten minutes a kind of explosion is heard, apparently proceeding from under water at some 40 yards distance from the shore. During the four hours he sat by the margin of the lake, these curious and inexplicable sounds were repeatedly heard: the sound was not sharp like the report of a gun, nor like the noise of falling rocks, but a dull, heavy concussion; the surface of the water was not in any way disturbed over the part whence the sound apparently proceeded. One of the men of the *chauki*, or guard house on the banks of the lake, told him that these sounds were caused by the breaking up of ice at the bottom of the lake. But on this hypothesis the fragments must necessarily have floated to the surface of the water; no ice however was visible on the lake except a fringe of shore ice along the margin.

NARRATIVE of the Route Survey of L——Explorer, from Darjeeling to Shigatze, Chetang, and Tawang; and from Shigatze back to Darjeeling via Giangche Jong and Phari, in 1875-76.

1. Having taken latitude observations at Darjeeling, compared his thermometers, &c., Explorer L—, on the 29th March 1875, started from Darjeeling for Shigatze, with orders to proceed *viâ* the Tibetan frontier out-post of Gánpá Jong. The explorer had with him as companion a man well acquainted with the Tibetan language, but had considerable difficulty in procuring three men to serve him as coolies for the trip, as the route he had been instructed to take is supposed to be closed to all but Tibetan officials.


THIS MAP
ILLUSTRATES
THE REPORT ON EXPLORER L.'S ROUTE THROUGH
SIKKIM and GREAT TIBET
via SHIGATZE and CHETANG
AND FROM
SHIGATZE TO KALINGPUNG
via GIANGCHE-JONG and PHARI
IN 1875-76.
Note.—The Explorer's route is colored red.
The district names have been taken from Mon. Gay's map.

COMPILED UNDER THE ORDERS OF MAJOR GENERAL J. T. WALKER, C.B., R.E., F.R.S. &c., SURVEYOR GENERAL OF INDIA, AND SUPERINTENDENT GREAT TRIGONOMETRICAL SURVEY, AT THE HEAD QUARTERS OFFICE, DEHRA DUN.

2. Starting work from the Darjeeling bazár, he descended to the bridge over the Rangit River, crossed it, and ascended to the village of Namjehiungmá in Sikkim territory. From this place his route to Thángú is over a line of country which had been traversed by Dr. Hooker, and is shown in his map of Independent Sikkim. In Namjehiungmá is a small monastery occupied by 8 lámás.

Darjeeling to Thángú.

3. From this place the road ascends for 4 miles through forest; a descent of 6½ miles then took the explorer down to the right bank of the Teesta River. For 9 miles further, the roads follows the bank of the river as far as a cane bridge over the Teesta, across which goes a road to Phárí; from this bridge the road, still keeping to the right bank, goes up about 4 miles to the crest of a mountain spur whence a descent of another 4 miles leads down again to the river; here is another cane bridge known as the Pasamjhúlá, which is 80 paces in length, about 20 feet above the water, and not passable for baggage animals.

4. Crossing on the Pasamjhúlá to the left bank, the road still keeps the general direction of the river, and about 3 miles from the bridge is the village of Dábiá whence a path is said to lead across the range of mountains to the east into the Chhumbí Valley and to Phárí. Passing through splendid open forest and by several villages, the explorer reached the junction of the Láchhung and Lásính Rivers, which united form the Teesta; the Lásính, the western branch, is apparently the larger of the two, and brings down the greater volume of water. Crossing the Láchhung to the village of Changtháng by a good wooden bridge well planked and covered with earth, he noticed another branch road going off eastward along the right bank of the Láchhung and said to go to Giángche Jong. About a mile beyond Changtháng he reached the village of Rámá, and crossed the Lásính River by a cane bridge 60 paces in length and about 30 feet above the water. Four miles further on he recrossed the Lásính by a wooden bridge about 25 paces long; and about a mile and a half beyond this, crossed a bridge which is enveloped in the spray of a stream which falls over the rocks above from an immense height, and sweeps under the bridge into the Lásính River close by with tremendous force. Six miles beyond this bridge is Lamteng, or Lásính Chaukí a village of some 60 houses. Here reside a Tibetan and a Sikkim official who are called *Chipan*, and who guard the road and levy taxes on any merchandise which passes.

5. A party of six Tibetan merchants, returning from a trip to Calcutta with indigo, cutlery, cloth, and drinking cups, were found here; they had left Darjeeling a month before the explorer, but were detained here till instructions concerning them were received from Lhásá. The merchants had chosen this route on account of the low rate of the tolls; on the usual Phárí route Rs. 30 per donkey load is charged for indigo, whereas at Lásính Chaukí only Rs. 5 per load was charged. On the other hand, however, there was the objection against allowing any traffic on this route, except official, which had resulted in their detention. Between Lásính Chaukí and Shigatze there is a small trade in madder and planks, yáks being employed for carriage. Lásính Chaukí is about 7,500 feet above sea level.

6. After a detention of 6 days the explorer was allowed to pass on; but he afterwards heard that the merchants were not released till a month latter. From Lásính Chaukí the road becomes practicable for laden animals; at about 4½ miles is the village of Níuán, situated in an extensive plain; the houses were found full of property but deserted, no one being left in charge. Crossing the Lásính to its left bank by a bridge at the village of Jámtong, a march of some 6½ miles took him to Thángú, which he reached on the 20th April 1875.

7. In the houses of Thángú were stores of grain and cooking utensils, all unguarded, the owners not intending to come up from their winter quarters at Lásính Chaukí till the month of May. A mile and a half beyond Thángú is a wooden bridge over the Lásính—here an inconsiderable stream fordable though swift, its breadth only about 20 paces. Here all forest and jungle were left behind, and nothing was to be seen but a few stunted trees and occasional patches of grass. Eleven miles from Thángú are the two Sarolá Lakes, separated from each other only by the road: the eastern one about a square mile in extent and rather deep, the western one somewhat smaller and shallow. Round about the lakes were patches of a small plant which yáks will eat, but which sheep and goats refuse to graze on; near the lakes are numbers of

Thángú to Gánpá Jong.

The explorer L—is a hill man of Sirmoor, and he seems to have been unable to catch the local pronunciation of the names of the places he has visited in Sikkim and Tibet. His spellings have been preserved throughout his narrative. The usual renderings are as follow:—

For Chakhjamchhuri *read* Chaksamchori or Cházumchori.
For Changtháng *read* Cheungtong or Choongtam.
For Gánpá Jong *read* Khamba Jong or Kamba Jong.
For Giamchana *read* Giamsena. *For* Jilíph La *read* Jelep La.
For Lásính *read* Lachen. *For* Lindam *read* Lingdom.
For Mautángong *read* Mantangong. *For* Namjehiungma *read* Namchi.
For Paina Jong *read* Pena Jong. *For* Painachhu *read* Penanangchu.
For Pasamjhúla *read* Ralakjhúla? *For* Phaglung *read* Pálung or Phallung. *For* Rangit *read* Rangyit.
For Ringjingpaon *read* Rinchingaon. *For* Samyá *read* Samaye or Samie.
For Sindam La *read* Singtam La. *For* Thángu *read* Tángu.
For Thuna *read* Teuna. *For* Yamdochho *read* Yamdokcho.
For Yási *read* Yarchi.

*

low stone wall enclosures used as folds for sheep and oxen during the warm season when there is plenty of a sort of grass, the roots of which the animals eat.

8. From the lakes the road continues to ascend for 6 miles to the summit of the pass, which is known by the various names of Sarolá, Lásính Lá, Tháchang Lá, and Kángrá-lámá Lá: the low snowy range from the west dies out at the pass, and to the east of the road are extensive plains. The height of the pass is about 16,500 feet. On the summit of the pass, by the side of the road, are three small heaps of stones with a number of sticks about them, to which are tied bits of rag and paper with prayers written on them. These piles of stones mark the boundary between Tibet and Sikkim, and devout travellers never fail to make the circuit of them, hat in hand, muttering the usual formula of prayer. A mile and a half beyond the pass is a tiny lake; a mile beyond this again is a road going off eastward to Tháchang Gunpá: from here the road descends at a slope of about 7° for 1½ miles, and about 7 miles from the foot of the descent is the fort of Gánpá Jong, situated in the midst of an extensive plain. Scattered over this plain in little clusters are the tents of shepherds, part of whose duty it is to give warning at the fort of the approach of travellers. Every tent has its complement of large dogs which are chained up during the day and let loose at night to scour the country, and are very dangerous. When about 3 miles distant from the fort, three unarmed horsemen galloped up and ordered the explorer's party into Gánpá Jong for due enquiry into their business, &c.; shortly afterwards five horsemen armed with swords and guns (port fire) came and took them in charge and brought them before the *Jong* or Governor. He asked them a few questions and then assigned the explorers a house outside the fort, where two armed men mounted guard over them with their horses picketed close by, ready saddled and bridled.

Gánpá Jong to Shigatze.

9. The fort of Gánpá Jong is circular, about 1,500 paces in circumference, and is built upon a small mound; the walls, 6 feet thick, are built of uncemented stones. In the middle of the fort is the entrance to a subterranean passage which leads to a small stream of water that washes the base of the mound on which the fort stands. The fort is used as a jail, and in it were confined some 50 prisoners, all for minor offences. The Jong is assisted by three *Nirpas* or writers, and every third day a runner is sent to Shigatze with letters.

10. On the second day after the arrival of the explorer and his party at Gánpá Jong, they were ordered to Lungdung, a village some 5 miles distant along the road to Shigatze, and here they were carefully watched, the men of their guard being changed thrice a day, the horses only once. Provisions were procurable at the following rates: *Chamba* or *Sattu*, a kind of barley, at six seers per rupee, Nepal rice at five seers per rupee, and a day's supply of fuel for an anna. The only fuel was dried yák's dung. Negotiations for their release proceeded slowly, and the explorer fell ill. On the fifteenth day of their confinement a *Nirpa* from the fort arrived and ordered them to proceed without delay to Shigatze, any carriage which they required being supplied to them.

11. From Lungdung the road traverses an extensive plain, and at 15 miles a road coming from the west from Singsohulung joins it. Singsohulung is said to be six marches distant, and to consist of two villages built on the slope of a hill, the upper one called Singso, and the lower Singsa. The road from Singsohulung to Gumá is constantly travelled by Nepalese trading to Shigatze; Gumá is a village on the Shigatze road, 16 miles from Lungdung. At about 15 miles from Gumá the road ascends a moderate slope for half a mile to the summit of a pass called the Lásum Lá. From this pass 7 miles a slight descent leads to the Bhádur plain, covered with villages and cultivation. The village of Bhádur consists of 14 groups of houses, three to the east of the road and 11 to the west; each group contains about 30 houses. Through the middle of the valley a small stream flows gently to the west; the fields are irrigated and manured; the crops are principally peas and barley.

12. Six miles beyond Bhádur is a monastery containing 500 lámás; there are 5 gilt bosses on the roof of the principal building. Nine miles further on is a slight ascent to the pass called Gámpo Lá where the road crosses a range of hills with peaks about 1,000 feet above the level of the surrounding country: the descent on the other side is a mile and a half long, steep and stony; this is the only bit of road between Thángú on the Lásính and Shigatze that would be difficult for the construction of a cart road. In the plains lying at the foot of the slope, the explorer saw many herds of antelope. At the village of Rabgiáling is a plantation of dwarf *maznu* (willow) trees, the first trees met with since leaving Thángú. From Rabgiáling the road, passing the large villages of Lugri and Láchhung, meets the great road from Ladakh at the S.E. corner of the outer wall of the great Tashílumbo monastery which adjoins the Shigatze bazár. Shigatze is usually pronounced Jigárche by the Nepalese.

13. The explorer arrived at Shigatze about the 15th May 1875, and soon after taking up his quarters at the *Tarjum* (or travellers' rest-house and encamping ground) he was questioned by messengers from the Governor, news of his coming having preceded him. The explorer was taken before the Governor in the *Kachahri* of the fort, and, after some questioning, was told to come again in three days time. He thinks that he would speedily have obtained his dismissal, but for the suspicions of one of the *Nirpas* from Gánpá Jong, who was very troublesome. It was finally determined that he could not leave Shigatze till the arrival of certain traders whom the explorer said would probably recognize and vouch for him. On

one occasion he obtained 15 days leave to visit Giángche Jong, and intended making his escape on his way there; but he found himself so closely watched that he gave up the idea and returned to Shigatze. Finally, on the arrival of the expected traders, he succeeded in making arrangements through them; and at the end of October was told that he was at liberty to go where he pleased.

14. While the explorer was in Shigatze, information was brought in that the Lieutenant Governor of Bengal and the Commissioner of Darjeeling were in Sikkim and had reached the Chola pass. This news caused the greatest consternation; detachments of troops were sent off to all the Sikkim passes, and 13 companies of Tibetan soldiers from Lhásá with 10 mounted officers marched in to garrison Shigatze. Each company comprised 30 to 40 men. These troops were armed with swords, and a gun to every two men. The guns are very heavy; in action the muzzle is supported on two sticks which are hinged on to the woodwork under the barrel; one man places the butt against his shoulder and takes aim while another touches it off. The force had two buglers whose instruments were of brass, about 6 feet long, straight, and with a huge bell-shaped mouth, which was rested on the shoulder of another man whenever the bugler sounded.

15. Sometimes the soldiers went out for ball practice, having as a target a wall of considerable size; whenever the wall was struck by a bullet, a bugler concealed behind the wall blew a blast. On two or three occasions there were parades, at which the manœuvres were rather curious. Each company clustered round its officer in any way it pleased, and then they marched in a confused mass to the fort and disposed themselves in two bodies: one party enclosed a large circular area with a cloth screen about 3½ feet high and remained inside it as a defending force; the party outside forming the attacking force, surrounded the enclosure, and then both parties fired away at each other till their ammunition was exhausted. The towns-people appeared to take great interest in these evolutions, and also in the target practice. When the explorer first reached Shigatze there were only 100 soldiers in the fort.

16. The monastery of Táshílumbo contains 3,800 lámás. Its walls are 15 feet high, 5 feet thick, and built of large sundried bricks, the whole structure being whitewashed. The buildings are numerous and large, and many of the roofs are gilded. The bazár of Shigatze covers an area of 1200 paces by 1000, and contains, specially set apart, Kashmiri and Nepalese quarters. Quantities of newspapers come from Darjeeling, and most of the houses have their walls decorated with them. There is however very little traffic between Shigatze and Darjeeling *viá* Gánpá Jong, notwithstanding the excellence of the road; during the 15 days the explorer was detained near Gánpá Jong not a single merchant passed.

Shigatze to Yásí.

17. In November 1875 he left Shigatze and again commenced work. Three and a half miles from Shigatze is the enclosed garden of Kunkyáling, 600 paces by 300, with a small lámásery situated in its midst; near the garden is a bridge over the Painá Chhu River, which is 80 paces in length, and constructed of large wooden beams resting on four large piers built of uncemented stones; the bridge is 4 paces wide and has no side rails. The banks of the river are moderately steep, the current gentle, and the water alive with large fish; during floods the river is said to rise 12 feet above the ordinary level. After crossing to the right bank of the Painá Chhu, the explorer followed it down for 2½ miles to its junction with the great river of Tibet called the Dugshum above the junction, and the Ekyáp Sángpo below. He could not give any precise idea of the size or width of the river; in places it flows in several channels and in others spreads out into a great expanse of water with hardly any perceptible current. For 50 miles he travelled along the right bank of the Sángpo to Jagsá, passing many villages on the road, and seeing others, and, at places, extensive cultivation some distance off inland. The banks of the river are shelving and the water probably never rises more than 6 feet above its mean level; the bed of the river is stony in places, but the stones are not large; there are large expanses of sand, and the current is slow. On the left or north bank many villages were seen; the margin of the river for a width of from 20 to 80 paces was bound in ice, but the river is said never to freeze over entirely. Sometimes the country is flooded in places, especially about the village of Taktúkhá, but the water does not go far inland.

18. There is a regularly organized goods and passenger traffic by boat down stream from Shigatze to Jagsá, divided into two stages at the village of Nimo, which is about 20 miles from the mouth of the Painá Chhu; the boats used are oblong in shape, flat-bottomed, and formed of leather stretched over a wooden framework. Arrived at the end of a stage, the boatman draws his boat on shore, dries it, and then carries it back on his shoulders to the upper end of the stage again.

19. The houses near the river have the lower 3 feet of their walls built of stone, while the upper portion is of unburnt brick; the houses are low, with sloping roofs covered with earth. Some of the houses cover a large area and contain many little rooms, each occupied by three or four persons; the windows are small openings with wooden gratings, and are few in number.

20. A plain varying from 3 to 5 miles in width stretches from the north bank of the river to the foot of a range of rounded hills about 1000 feet above the surrounding country; opposite Jagsá this range falls into the left bank of the river. A range of snow-clad hills closes in on to the right bank of the Sángpo about 3 miles to the east of Jagsá, and there is said to be no road along this bank the river here entering the hills and falling over many rapids;

there is no boat traffic between Jagsá and the iron chain bridge of Chakh-jamchhurí over the Sángpo near Lhásá.

21. From Jagsá the road turns S. E. and enters the district of Rungchung; 5 miles from Jagsá is the village of Jámchhen, and a monastery of 1500 lámás. The plain about Jámchhen is studded with small villages. Beyond Jámchhen is the monastery of Humídolmá containing 900 lámás: from here the road runs through a fertile valley containing several villages, and about 13 miles from Humídolmá is the village of Chhuchhen, (from *chhu*, water, and *chhen*, warm) built on a mound from the base of which issues a small stream of water whose temperature is 152° F. The water issues in little jets and is conveyed by a short trough to a little pool in which the sick bathe. The water is not unpleasant to drink, but it has a bluish tinge and a strong sulphurous smell.

22. From Chhuchhen the road passes several villages, two small monasteries, a lake 400 paces long by 200 wide, and, at 26 miles from Chhuchhen, joins the road from Giángche Jong to Lhásá at the village of Yásí on the margin of the Yámdochho Lake. The range of snow-covered hills overlooking the village of Jagsá on the east, continues on parallel with the road to the Yámdochho Lake; but it diminishes in height as it gets further from Jagsá. To the south of the road lie plains bounded by low hills which in places are close to the road, and in places are 4 or 5 miles distant.

23. Between Shigatze and Yásí there is considerable traffic; the explorer met or passed 300 or 400 men with loads every day; for 3 days he travelled with some 30 Nepalese merchants on their way to Lhásá with cloth and brass vessels; and he met many Kashmiris returning from Lhásá with brick tea. A brick of tea, size about 9″ by 4″ by 2″, rarely costs more than ten annas; it is composed of large, coarse leaves and stalks which have undergone very little manufacture. The orthodox method of preparing the liquor is to pound the tea to powder and boil it with a sprinkling of salt; when boiled it is poured into a long wooden cylinder, a lump of butter added, and the mixture thoroughly churned; it is then reheated over the fire before drinking.

Yásí to Chetáng.

24. From Yásí the road traverses the western margin of the Yámdochho Lake for 17 miles, as far as the village of Dámálúng; here the road leaves the lake and, turning northwards, crosses the range of hills, bordering the lake on the north, by the Khamba Lá. There are two roads up the ascent; the one for horse traffic is easy, and a little more than half a mile in length.

25. The Yámdochho Lake is at least 2 miles wide opposite Yásí; at Dámálúng its width does not exceed half a mile. The eastern shore, visible from between Yásí and Dámálúng, is an expanse of flat land, from which rises a mass of mountains culminating in a rounded peak called Tungchín, which attains an elevation of about 2,000 feet above the level of the lake, the latter being about 13,700 feet above sea level. On the slopes of this mountain the explorer saw herds of yák and sheep grazing, and in a valley he noticed several houses. He was informed that the lake has no outlet, and that it does not (as hitherto supposed) completely surround the Tungchín Mountain; for the flocks of yák, sheep, and goats which graze on the slopes of that mountain can get on it without crossing water. A path at the south end of the lake, branching off from the road between Giángche Jong and Yásí, 9 or 10 miles from Yásí, is said to lead across a wide expanse of boulders and big stones to the mountain. As however, no traveller has yet been round the lake the accuracy of the above report remains in some little doubt.

26. From the Khamba Lá there is an easy descent of about 5½ miles, and some 4 miles further the village of Jámá on the *right* bank of the Sángpo is reached. Here the road divides, one branch going N.E. to Lhásá, crossing the Sángpo by the Chakh-jame chhurí iron bridge, 3 miles from Jámá; the other continuing eastward down the river. The explorer having been ordered not to go to Lhásá, took the eastern branch of the road, skirting the southern base of an isolated mountain about 1500 feet high, situated between the fork of the two roads, and 6 miles from Jámá, came again close on to the right bank of the Sángpo. Following the bank for 4 miles, he reached Kukhang village, protected by a fort, and containing a monastery with 1500 lámás. The fort, 800 paces in circumference, is on the bank of the river; its walls are 30 feet high, of rough uncemented stone; the garrison consisted of 7 or 8 soldiers only, as a guard for the Governor.

27. From Kukhang the road passes through many villages, one of which, Dáchang-rángmít, contains at least 250 houses. Seventeen miles from Kukhang is the fort, monastery, village and large bazár of Kirtíjung. This fort is 600 paces in circumference; its walls, 15 feet high, are in ruins in many places. In none of these so-called forts are the walls loopholed or crenellated, or any means supplied to promote an effective fire: the defenceless state of these enclosures may be due to political reasons.

28. Between Jámá and Kirtíjung there are many great expanses of sand in the bed of the Sángpo. The plain bordering the north bank of the river is from 2 to 5 miles in width, full of villages, and bounded on the north by a range of low hills culminating in the fine peak of Durjethá, to the north-east of the village of Kirtíjung, about 3000 feet above the river. The plain to the *south* of the road varies from 2 to 5 miles in breadth, bounded by low, rounded hills which are uninhabited.

29. Fifteen miles from Kirtíjung is the village of Jhánpáling containing 300 houses, and a mile beyond the village is a monastery with 700 lámás. Nine miles from Jhán-

páling, but on the left bank of the Sángpo, is the famous monastery of Samyá which contains 1400 lámás. The buildings in this monastery are large and very lofty, many of the roofs being gilt, and it is a renowned place for pilgrimage. The road continues along the right bank of the Sángpo through plain country, and 40 miles from Jhánpáling enters the bazár of Chetáng, a mass of buildings covering an area of 600 paces by 400. A daily open-air market is held here which is well supplied; and here also may be purchased goods of all kinds from Calcutta, China, Kashmir, and Nepál; this bazár is also famous for the sale of perfumed sticks ("Joss-sticks") that are burnt in the temples. In the monastery at Chetáng there are 700 lámás; it is 700 paces in circumference. The explorer always followed the Tibetan custom of making the circuit of a monastery, hat in hand. He saw various curious methods of making the circuit adopted by the Tibetans, some walking round on their knees, and others laying off the length of the body fully extended on the ground successively till the circuit was completed, even if it took them all day to get round thus. The fort of Chetáng is a little way out of the town, and is in the same partly ruinous condition as the other forts before mentioned. It is about 600 paces in circumference, and has a garrison of about 40 men.

30. At Chetáng low hills come close down to the south bank of the Sángpo; the hills bordering the plain on the north bank of the river are also low. From here the river was seen trending away to the horizon about east by north in a wide valley, the view down which was bounded by a snowy range apparently a great distance off. The explorer was told that after flowing in this direction for 15 marches the river turned south, and, passing through a wild mountainous region, entered a country governed by the English. This accords with the generally received opinion that the Sángpo enters Assam as the Dihang River, flowing into the Brahmaputra 12 miles below the frontier station of Sadiya.

31. The road continues along the right bank of the Sángpo past Chetáng, but the officials warned the explorer against going along it unless he accompanied a strong body of merchants; for it is beset by thieves, and there are wild turbulent tribes armed with bows and arrows to be met with near Chári.

Chetáng to Tawáng or Mautángong.

32. After remaining in Chetáng 6 days, the explorer, thinking he might run short of funds, left about the middle of December 1875, and turned southwards, intending to follow the route of Nain Sing into Assam. For some 13 miles from Chetáng the country is fertile and there are many villages along the road; but thence the country becomes bleak and barren. He probably took the alternative route from Chetáng to Tángshokh (Tángshú) mentioned by Nain Sing in his itinerary as passing through uninhabited country and used by traders from the Hor district. Twenty-seven miles from Chetáng he passed the two monasteries and village of Dhakyáling: snow-capped mountains here close in on to the road which ascends for 3 miles to the Yánto Lá pass, (16,300 feet) on which there is a frozen lake 300 paces in circumference. Three miles of easy descent and the road enters upon great, bleak, stony and barren plains. Seven miles from the pass is Karkang where is a house for travellers, and a small monastery containing 6 lámás. Karkang is at the trijunction of the districts of Chetáng, Photáng, and Niá. Here he met a small party of merchants going to Lhásá with loads of tea, salt, and rice, carried on donkeys and horses: these were the first travellers met with since leaving Dhakyáling. Beyond Karkang the country is very bleak and desolate; the plain through which the road passes varies in width from 1 to 10 miles, and is bordered by low undulating hills. Thirteen miles beyond Karkang is Giárokh, where are a few houses and some fields. Three miles beyond Giárokh is a road going south-west to Niá, which is distant 8 miles from the bifurcation of the roads. The explorer visited this place on his return journey from Tawáng: he found there a fort, 500 paces in circumference, built on a small eminence, with many villages scattered about on the surrounding plain.

33. Twenty-one miles from Giárokh is the small village of Sumná, and 4½ miles further a small stream, frozen over when crossed, draining to the south, crosses the road. From here the road ascends for 3 miles and then descends for a mile to a great lake*, 6 miles long by 4 wide, west of the road, which was frozen half over. The lake is bordered by low rounded hills, and several miles off to the east is a lofty range: near the lake is much short grass, and herds of antelope and wild asses (the *kyáng* of Ladakh, called *thá* in Tibet) were seen. Three miles beyond the lake is the Tángshokh† guard-house, and a large house for travellers. To the east and west, 10 miles distant, are ranges of snow-clad hills. Fourteen miles from Tángshokh is Chhuiná‡, where there is a large bazár, a monastery, and a detachment of mounted soldiers. In the bazár are the shops of 5 Nepalese who have married Tibetan women and settled at Chhuiná. The monastery is at the south end of the bazár; it is 700 paces in circumference and contains 120 lámás. The detachment of soldiers numbers 25 strong only; they are armed, some with spears and long straight swords, others with guns and swords. Chhuiná is situated in a large plain, 5 miles long by 4 broad, surrounded on three sides by low hills; there are several villages scattered over the plain, containing altogether not less than 500 houses. There is very little cultivation however, only a few small patches on the banks of the stream, the place being chiefly a trading mart. There are several

* The Nárá Yumcho of Nain Sing.

† Tángshú of Nain Sing.

‡ Chona Jong of Nain Sing: for a fuller account of this place, see report on Nain Sing's Explorations in 1874-75.

springs of warm water, colorless and almost inodorous, from which the inhabitants take their drinking water. Chhuiná is about 12,900 feet above sea level.

34. A mile and a half beyond Chhuiná the road ascends for a mile, and another road branches off to the south-west which is said to go to a considerable place called Lubrakh, near a large river. Nineteen miles from Chhuiná the road descends 2 miles and reaches the toll-house at Chhukháng, where a tax of three annas is levied on each traveller. Passing Chhukháng the road undulates a good deal, and the slopes of the hills are covered with trees like chestnut trees; ten miles off to the east of the road are visible great snowy peaks. Eight miles from Chhukháng is a small lake, 700 paces in circumference, which was frozen over. A mile beyond this lake the road enters a forest of gigantic trees, like deodár, of a greater height and girth than the explorer had ever seen elsewhere, and then goes down a continuous and moderately steep descent for about 5 miles to the important Tibetan post of Mautángong, or Tawáng. About 300 houses are scattered round about Tawáng, and there is heavy *ringál* (dwarf bamboo) jungle about the place, which is situated on a broad spur sloping to the south; a mile or so further down the slope is said to be the village of Mau situated on the boundary line between Tibet and the *Dhukpá* country or Bhotán. There is a Tibetan regiment 500 strong, quartered at Mautángong, commanded by 3 officers who also exercise civil functions. There are barracks for the soldiers, but no fort. There is also a large monastery*, 1000 paces in circumference, containing about 700 lámás; several of the buildings in this monastery have gilt roofs.

35. At Mautángong the explorer and his party were seized and taken before the authorities, who were inexorable in refusing to permit them to pass on, and sent them back to be confined in the public flour-mill at Kiákárong, 2 miles away; here they were detained a month, the only attempt at negotiations which they made resulting in a fine being inflicted on them. A party of some 300 traders from Tibet were also in Mautángong. They had intended going to a place they called "Giagarjámsetung" in British territory, but permission to proceed had been refused by the authorities. Two young men amongst them one day spoke their minds too freely on the subject of such arbitrary detention, and they were promptly placed in the guard-house, and their goods sold by public auction.

36. In the mill in which the explorer was confined, the lower mill-stone was circular, about 5 feet in diameter, and fixed; the upper one was rectangular, and revolved thus:—through the centre of the lower mill-stone a spindle, fixed in the upper stone, passed loosely; to the lower end of this spindle, some 3 feet below the stone, were fixed a number of flat boards radiating like the spokes of a wheel, thus making a horizontal water-wheel against which a small stream was conducted, and so caused the rotation of the upper mill-stone.

37. At length three mounted soldiers were told off to escort the explorer and also the two insubordinate Tibetan merchants to Lhásá. Fortunately however, before they got to Lhásá, the governor of a fort on the road objected to some informality in the document carried by the soldiers and ordered them to return to Mautángong, informing the prisoners they might go about their business. The explorer therefore made the best of his way back to Shigatze by the route he had come. The explorer suffered much from extreme cold and high winds on his journey from Chetáng to Mautángong and back thence to Shigatze. The aspect of the country between Chetáng and Mautángong he describes as very bleak and desolate.

38. With regard to the climate and weather at Shigatze, he states that during the month of May no rain fell, though the sky was cloudy. The rain set in about the middle of June, and there was a good deal of rain during the months of July and August: the prevailing wind was from the east. In September there was little rain, but it was very cloudy. In October there was no rain, and strong winds from the east set in, commencing regularly at 11 A.M., rising to their height about 2 P.M., and gradually declining till about 5 P.M., when they ceased: they rarely blew at night. These winds were extremely cold, and in December and January they increased to such tremendous violence that for three or four hours in the day, while they were at their height, no one stirred abroad as it was impossible to travel in them.

Shigatze to Phárí.

39. About the end of March 1876, the explorer completed his arrangements at Shigatze for returning to Darjeeling by travelling in the foot-steps of Captain Turner, who in 1783 went from Shigatze to Phárí: from Phárí the explorer intended taking the road over the Jílíph Lá to Darjeeling. From Shigatze he followed the same route as that taken by Nain Sing in 1866-67, as far as the bridge over the Painá Chhu at Painá Jong; but from there he kept to the left bank of the river. Some distance beyond Painá Jong, the hills come down close to the road, and there is one large and very steep hill called Kurírádon overhanging the river, which is famed as the haunt of robbers, whose mode of attack is to sling down stones at the solitary traveller, who drops his load to escape across the river. The explorer travelled in company with 14 or 15 merchants, and except that several men came up and boldly demanded alms, they were not molested. A mile from this hill is the monastery of Nurbugiángchá containing 300 lámás. Passing several villages and water-mills, they came to Cháchín monastery, 2000 paces in circumference, and containing 1000 lámás. Three miles further on

* For a full account of this monastery, and the large territorial jurisdiction and political influence held by it, see report on Nain Sing's Explorations in 1874-75.

is Manilágong village, and a bridge across the river; the bridge is 100 paces long and is supported on 5 stone piers. The river here is very swift. Half a mile from the bridge, on the right bank of the river, is the important town of Giángche Jong. The bazár covers a space of 600 paces by 300; the fort is large and built on an isolated mass of rocks overlooking the town; its walls are at least 40 feet high, but are in a ruinous condition in places.

40. From Giángche Jong a remarkable cluster of 8 needle-shaped peaks was noticed, bearing S.W., distant about 10 miles, and perhaps 3,000 feet above the level of the river. After a stay of a couple of days at Giángche Jong the explorer returned to Manilágong and travelled along the left bank of the Painá Chhu 11 miles to Changrá. Four or five miles east of Changrá are lofty snowy mountains. The hills bordering the west of the road are low and rounded.

41. From Changrá he left the Painá Chhu river and turned up the bed of a small stream flowing in a narrow valley bordered by low, rounded, sterile hills. Twelve miles up this stream he came upon a shallow pool of warm water in the rocks; the water had a blue tinge and slightly sulphurous smell; the outflow from the pool was very small. Eleven miles further on is Sálu village of 50 houses, with some cultivation about it. The road here is bordered by low hills of a reddish kind of gravel. Five miles beyond Sálu is the large village of Pika, and 4 miles beyond this again is the Kálápángá or Kalochhu Lake; the road passing along its margin for 2 miles to the village of Kálápángá. This lake is about 2 miles broad, and the villagers of Kálápángá are great fishermen, going out on the lake in their little leathern boats and fishing with line and hook baited with paste. They catch numbers of large fish, which are dried in the sun. About Kálápángá there is extensive cultivation irrigated by several small hill streams. Five miles beyond is the village of Chhálu on the banks of the small stream flowing from the Rámchho into the Kálápángá Lake. A mile from Chhálu the stream opens out into a chain of small lakes, and at 3 miles from Chhálu joins the Rámchho Lake lying to the east of the road. The explorer did not obtain any other name for this lake. The road crosses the little stream near its issue from the lake on a small bridge built on 2 stone piers.

42. The road now enters extensive plains, and at 19 miles from the Rámchho Lake it reaches the village of Thuná, situated about 12 miles N.N.W. of the great snowy peak of Chumalári (or "Phárí-Jumnu" as the explorer gives the local name) 23,900 feet high. Eleven miles beyond Thuná the road commences to descend a slight incline for 4 miles to the village of Chukyá; and 2 miles from Chukyá, in the midst of a large plain, stands the fort and small town of Phárí, from which place a road leads off about north-east into Bhotán.

43. The fort at Phárí is 1,500 paces round, and its walls, built as usual of rubble stone, are 30 feet high. There are no fields or cultivation about Phárí; the inhabitants of the 60 or 70 houses which form the town surrounding the port own large herds of sheep and yáks, and employ themselves exclusively in the carrying trade. *Sattu* and *áta* (barley and wheat flour) are imported from Giángche Jong, and rice from Bhotán; their own flocks supply them with meat.

Phárí to the Jílíph Lá Pass.

44. At Phárí there are 3 Chinese officials and 30 mounted soldiers. The explorer was arrested here and detained a month; and matters would have gone hard with him but for the kindly interference of one of the leading men of the village, who eventually procured his release. Leaving Phárí, at 5 miles from it, he crossed to the right bank of a small stream, the Ammochhu, and entered a great forest. From here the road descends a slight incline for 7 miles, and 12 miles from Phárí it again crosses the river Ammochhu to its left bank; here the stream is not fordable. Five miles beyond the bridge by which he crossed he emerged from the forest and reached the village of Kálíká which belongs to the country of *Dumi* or Sikkim. From here the road descends a slight incline for 4 miles, and at 5 miles from Kálíká is Chhumbi, the summer residence of the Sikkim Rájá. All the houses in this village are roofed with planks; the Rájá's palace is not large, but the roof is handsomely gilt. There is also a small monastery here. A bridge 30 paces in length spans the Ammochhu River, and crossing this, 4 miles down the stream, the explorer came to Ringjinggám, the houses in which are all very large and are roofed with planks. At Ringjinggám he left the Ammochhu, and entered a forest of huge pine trees, the road ascending continually, but with an easy slope, to a small lake, 300 paces in circumference, on the summit of the Jílíph Lá Pass. Snow was lying on the peaks along the ridge while he crossed this pass, from which a good road has been made into Darjeeling by the British Government.

45. The explorer proceeded *viâ* Kálingpung to Darjeeling, where he arrived in July 1876, after an absence of one year and four months from British territory.

As these pages are passing through the press Lieutenant Harman is completing a survey of Sikkim, which is singularly corroborative of the general accuracy of Dr. Hooker's map. Lieutenant Harman has, however, found that the pass which is on the boundary line between Sikkim and Tibet, and which Dr. Hooker calls in his volume the 'Kongralámu' is the Giagong Pass, while the Kongralama Pass is six or seven miles to the north, as stated by L——; it is the higher pass of the two, and its position is shown (without any name) in Dr. Hooker's map on the range between the Larben and the Arun rivers.

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Narrative of the Second Expendition of Explorer L——in 1877.

The object of the second expedition of the explorer over portion of the ground which he had traversed in his first journey has already been explained in paragraph 8 of the Introduction to his former narrative. He was ordered to proceed to the Kángrá-lámá Lá and to determine its latitude and that of several other points on his former route. His instructions were to visit first the G. T. Station of Senchal, situated not far from Darjeeling, in order to find and recognize a number of trigonometrically fixed peaks in the neighbourhood of his former route, the bearings of which from Senchal H. S. were given him. He was then to resurvey the small portion of his route from Darjeeling to the Rangit, and thence to proceed to Patam for his first latitude observations. After taking bearings to all visible fixed peaks from the nearest hill-top, and connecting that hill-top by a short route survey with the place where he had observed latitude, he was directed to proceed to Changtháng village and thence to the Kángrá-lámá Lá to observe their latitudes and check their positions by bearings as before. In the case of his failing to reach the Kángrá-lámá Lá on account of snow, he was directed to take his northernmost latitude observations at the Sarolá Lakes, and to carry a route survey from there to Darjeeling again *viâ* Phárí.

The explorer left Darjeeling on the 29th September 1877, accompanied by a Lepcha, who was well acquainted with the country up to the Kángrá-lámá Lá, and 3 coolies. His instrumental equipment consisted of a pocket compass, a prismatic compass, and a 6-inch sextant. He proceeded to Senchal H. S., distant some 7 miles from Darjeeling, but was detained there for a whole month before he could take the bearings of the trigonometrically fixed peaks and recognize them, as the weather was very cloudy the whole time. On the 27th of October it cleared up for a while and enabled him to see all the peaks: he then returned to Darjeeling. On the 29th October, starting from the Darjeeling bazár, he carried a route survey down to the right bank of the Rangit river, near Rangit village. The river here is deep and cannot be forded. The first portion of this route lay through tea-plantations; the remainder through thick forest. Crossing the Rangit by a *jhula* or cane bridge, the explorer proceeded to Patam where he took observations for latitude, and then ascended a hill near by called Phiram to take bearings to peaks; in this, however, he failed owing to the cloudy weather. From Patam he went to Changtháng at the junction of the Lásính and Láchhung Rivers, where he remained for 3 days, but was unable to get any observations owing to the clouds. Fearing to delay on account of the lateness of the season, he pushed on through Lásính Chaukí (Lamteng) to Thángú; but the sky being still heavily overcast, he wasted no time here waiting for it to clear, but proceeded to the Sarolá Lakes. Near the lakes his progress was temporarily arrested by some Tibetan officials who ordered him either to return or to show a *parwána* (order or permit) from the Sikkim Rájá. On giving them a bribe, however, he was allowed to proceed. At the Sarolá encamping ground he was again met by the same demand from other Tibetan officials, who were also bribed in their turn, and he proceeded to the Giamchana Lake, a few miles further. Here he was for the third time questioned, and peremptorily ordered back, so he returned for a short distance, and halting for the night at a station of his former route survey (No. 167), took observations for latitude there, as he saw no hopes of being permitted to proceed quite up to the Kángrá-lámá Lá. He then returned to Thángú, and taking his observations for latitude there, attempted to ascend the Phaglung hill, about five miles east of Thángú, but was obliged to give it up on account of a heavy fall of snow.

From Thángú the explorer returned to Changtháng, where he had to remain 8 days before the sky was clear enough to enable him to observe the latitude. He then ascended a hill close by for bearings, but did not succeed in obtaining any as the clouds had again come up and hidden the hill-tops. From station No. 108 of his former route he then traversed up the Láchhung River a short distance, and thence to the Thánká Lá, a pass about 8½ miles east of the village of Láchhung. The road up the Láchhung River as far as the village was good; it crossed the river in three places by wooden bridges, 39, 35, and 15 paces in length respectively. From the Thánká Lá he obtained the bearings of Chumalári, Kanchinjinga, and two other well-known peaks.

From Thánká Lá the explorer marched to Sindam Lá, about 2 miles north of Patam, where he took observations for latitude. He then carried a route survey up to a hill about 12 miles to the west, and succeeded in obtaining the bearings of several trigonometrically fixed peaks. This hill is called the Karangit Kurson Lá or Karkang Lá; and near it, according to local rumour, is a large lake (surrounded by red stones) which, on the approach of any one, overflows its banks and drowns the inquisitive intruder. The explorer endeavoured to visit this wonderful lake himself, but there being no path, and the forest being dense and impenetrable, he gave up the attempt.

Returning from Patam to the Rangit, the explorer proceeded to Kálingpung, and from there took a traverse *viâ* Rangit to his original starting point—the Darjeeling bazár.

A tabular statement of the explorer's latitude observations is appended.

Compiled under the supervision of J. B. N. Hennessey, Esq., M. A., F. R. S., Deputy Superintendent, 1st Grade, Survey of India, in charge Head-Quarters' Offices, Dehra Dun.

Observations for Latitude taken by Explorer L—on his Route from Darjeeling to Kángrá-lámá Lá, in 1877.

Object Observed	Stations of Observation									
	Patam		Changtháng		Thángú		Giamchana		Sindam Lá	
	Date	Double Altitude	Date	Double Altitude	Date	Double Altitude	Date	Double Altitude	Date	Double Altitude
Sun „ „ „ „ „	Nov. 8th	92° 37′ 20″	Nov. 16th „ 17th „ 18th Dec. 3rd „ 6th „ 7th	87° 51′ 0″ 87 21 40 86 52 40 81 10 0 80 22 30 80 8 30	Nov. 27th	82° 30′ 0″	Nov. 24th	83° 18′ 30″	Dec. 22nd „ 29th	78° 56′ 40″ 79 23 0
Polaris „ „					Nov. 27th	58° 33′ 20″	Nov. 24th	58° 51′ 0″	Dec. 19th „ 22nd „ 29th	57° 33′ 20″ 57 33 10 57 33 20
Sirius „	Nov. 8th	92° 15′ 20″	Dec. 6th „ 7th	91° 48′ 10″ 91 49 0	Nov. 27th	91° 12′ 20″	Nov. 24th	90° 56′ 30″	Dec. 29th	92° 13′ 20″
Rigel	Nov. 8th	108° 39′ 0″	Dec. 7th	108° 13′ 10″	Nov. 27th	107° 39′ 0″	Nov. 24th	107° 20′ 0″	Dec. 29th	108° 37′ 30″
α Hydræ „			Dec. 6th „ 7th	108° 39′ 0″ 108 39 30	Nov. 27th	108° 2′ 30″				
Fomalhaut „ „	Nov. 8th	64° 50′ 0″	Dec. 3rd „ 6th „ 7th	64° 22′ 20″ 64 22 30 64 22 20			Nov. 24th	63° 28′ 40″		
β Ceti „ „	Nov. 8th	88° 2′ 30″	Dec. 3rd „ 6th „ 7th	87° 36′ 0″ 87 35 30 87 34 30			Nov. 24th	86° 42′ 20″	Dec. 19th „ 22nd „ 29th	88° 0′ 30″ 88 0 30 88 0 40

Note.—Each of these double altitudes must be diminished by 4′ 30″ (index error of the sextant) before finding the corresponding latitude.

Resulting Latitudes.

Object Observed	Patam	Changtháng	Thángú	Giamchana	Sindam Lá
Sun " " " " "	27° 22′ 58″	27° 36′ 28″ 36 21 36 26 36 5 36 31 36 37 Mean 27° 36′ 25″	27° 54′ 9″	28° 4′ 24″	27° 24′ 6″ 25 54 Mean 27° 25′ 0″
Polaris " "			27° 52′ 31″	28° 1′ 21″	27° 22′ 34″ 22 30 22 36 Mean 27° 22′ 33″
Sirius "	27° 22′ 48″	27° 36′ 17″ 35 51 Mean 27° 36′ 4″	27° 54′ 15″	28° 2′ 11″	27° 23′ 36″
Rigel	27° 23′ 2″	27° 35′ 52″	27° 53′ 0″	28° 2′ 30″	27° 23′ 38″
α Hydræ "		27° 35′ 28″ 35 44 Mean 27° 35′ 36″	27° 54′ 0″		
Fomalhaut " "	27° 22′ 34″	27° 36′ 22″ 36 17 36 21 Mean 27° 36′ 20″		28° 3′ 14″	
β Ceti " "	27° 22′ 39″	27° 35′ 52″ 36 6 36 36 Mean 27° 36′ 11″		28° 2′ 44″	27° 23′ 34″ 23 34 23 28 Mean 27° 23′ 32″
Mean Latitudes	27° 22′ 48″	27° 36′ 5″	27° 53′ 35″	28° 2′ 44″	27° 23′ 40″
Lat. on Hooker's Map to nearest minute	27 24	27 38	27 53	27 56	

Errata in the Foot-notes to the Mullah's Narrative.

Page	xxiv,	line	12.—*After*	inhabitants of Swat, *omit*		" and of the Kandia valley."	
,,	xxv,	,,	9.—*For*	Porulosa	*read*	" Torulosa."	
,,	xxix,	,,	11	,,	Ghuz	,,	" Shin."
,,	,,	,,	12	,,	Kanza	,,	" Hunza."
,,	,,	,,	,,	,,	Yasir	,,	" Yasin."
,,	,,	,,	,,	,,	Tangis	,,	" Tangir."
,,	,,	,,	,,	,,	Darey	,,	" Darel."

The "Mullah's" Narrative of his journey up the Swát Valley to Kálám and Ushu, and across to the Indus Valley *viá* the Kándia Valley, &c., in 1878.

With foot-notes by Lieutenant-Colonel H. C. B. Tanner, Deputy Superintendent, Survey of India.

HAVING received my instructions, I proceeded home on a year's leave in order to allow all rumours as to my being in Government employ, to die out. I had every reason to believe that the fact of my being a Government employé had been suspected in the districts where my last season's work lay, and I feared that rumours concerning me might have spread into Swát, where I was known personally, having formerly visited the place, and being acquainted with many of the influential inhabitants. To further allay suspicion, I sent for a trader from Swát, and engaged him in my service, informing him that I wished to purchase timber either at Lámuti, where rafts could be formed and floated down the Panjkora river, or in the Kándia valley, whence the timber could be floated down the Aba Sind (Indus). These places are famed for their timber, and large quantities are yearly floated down from the former place to Pesháwar, and from the latter to Attock. Under my instructions the trader purchased hatchets, cloth of various kinds, indigo, &c., to barter and to pay coolies with, coin being in little request in Kohistán. He then proceeded to Swát to await further instructions from me.

2. Leaving Pesháwar on the 23rd April 1878, I proceeded to Abazai on the borders of British territories, and put up with a friend of mine, who knew I was in Government employ, but kept my secret. Through him I obtained the assistance of his uncle, who accompanied me to Michni; my instructions being to proceed thence to Lálpura *viá* the Kabul river. Here I tried to procure men to accompany me. I could have procured many, but they all insisted on going by the usual route, which was miles away from the river. I urged that my object was to proceed along the river, as a merchant had employed me to go up in search of some timber supposed to be stranded between Lálpura and Michni, but without avail. Every one agreed that it was impossible to proceed along the river banks even during the winter months. Whilst still endeavouring to arrange matters, some raftsmen from Lálpura arrived, and hearing of the question at issue, vouched for the fact that no timber was lying on the banks anywhere on the route they had just floated down. The head raftsman was an agent of the very merchant whom I had named as my employer at Pesháwar, and he assured me I need not be anxious about the matter, saying that my best plan was to proceed by the regular route to Lálpura and float down from there, inspecting both banks of the river; while he, meanwhile, would explain the case to our supposed mutual employer at Pesháwar. I had no alternative left under these circumstances but to give up this part of my journey and return to Abazai. On enquiring here about the route to Lámuti, which place I had been ordered to visit, I was informed that all the passes were closed by snow, so I returned home to Pesháwar for a while to await their opening.

3. On the 11th June I again left Pesháwar for Abazai; a Saiyid from Totai village escorted me into Swát. The Saiyids in the Swát district are held in great veneration and esteem, and parties under their escort or protection are never molested or robbed. Leaving Abazai on the 13th June I attempted to follow up the Swát river, called here the Jinde or Lundi, and occasionally the Swát-sind; *sind* in Pashtu meaning river. This, however, I found impracticable after a few miles, owing to the precipitous and rocky nature of the hills on each side of the river. I was therefore compelled to make a detour; and my first march from Abazai was *viá* Gandere to Kot; one of the villages known collectively as Kuza Totai, and containing about 1,000 houses. I arrived here late in the evening; and a charpoy being provided for the Saiyid, I also took a seat on it and began smoking with him, which proceeding scandalized the people very much who were looking on. The Saiyid, however, explained to them that I also was a *Saiyid* as good as himself, whereupon I was looked up to with great respect, and afterwards no one ever attempted to dispute my orders or wishes.

4. I left Kot on the morning of the 14th June and arrived at Náranj village. The road was very good and passable for laden ponies; the last two miles being an ascent. After crossing the spur of a long range of mountains, about five miles from Kot, I came in sight of the Swát river which flowed to my left, distant about a mile and a half. When I came close to the river I saw the village of Azgar on the opposite bank in the territory of Asíl. The Asíl tribe is considered rather a powerful one. From Náranj, at a bearing of 91° and distant 2⅝ miles is the village of Bara Totai, which, with Náranj and Kuza Totai, constitutes the *pergunnah* of Totai.

5. Leaving Náranj next day I reached Issar in the Swát district; the road was good, but there were many ascents and descents. It passed by the villages of Agra and Ingzre; the former at the foot of the ascent from the Agra nadi, the latter at the top

of the ascent from the Kám Agra nadi. In addition to these a few scattered villages were seen on each side of the road. The soil hereabouts consists chiefly of gravel without any large rocks or boulders, and owing to the gravelly nature of the soil little is procurable from the fields in the way of crops, which are hardly sufficient for local consumption. The chief produce is barley. The inhabitants are generally small traders, dealing in timber and charcoal in the Peshâwar district. They are also great robbers, and are all armed with flint muskets, in the use of which they are expert.

6. Starting from Issar village on the 16th June I halted in the evening at Kuz Badwán, after crossing the Swát river at Matkanai on rafts made on floats of inflated skins of cows or buffaloes: these rafts are here called *jála*. The villages on the road in this stage were Totekán and Matkanai on this side of the river, and the two Barangolas on the other. From the ferry, roads lead to Thána and Aládand; two large villages, distant, two and four miles respectively from the river, to the right of the road. The former village, Thána is famed for the office of *Khán*; having remained in the same family from time immemorial, and yet none of the *Khâns* have ever died naturally in old age, but have all come to some untimely end.

7. While waiting at the ferry for the raft to be prepared to take me across, one of the raftsmen enquired if I was not an inhabitant of Peshâwar; on my answering in the affirmative he mentioned that a murder had been committed on the spot I was standing on, several years ago, the murdered man being also from Peshâwar. I knew he spoke of my brother who was murdered in his first attempt at explorations. The raftsman explained to me that he and the other raftsmen were on the opposite side of the river, and that my brother was performing his ablutions previous to his prayers, when the murderer, who was his companion, shot him in the shoulder from behind, with a revolver. My brother turned round and grappled with him, trying ineffectually to wrest the pistol from his grasp, and in the struggle received all the six bullets in his body, the last one entering his chest, when he was pushed backwards into the river. When the raftsmen crossed the river the murderer had taken refuge in a neighbouring village; they pursued him, took him prisoner, and made him over to the Akhúnd of Swát.

8. On the 17th June having left Kuz Badwán about four miles behind me, I came to the Chakdara ferry at the foot of the hill over which the road crosses to Chakdara village by the Shamilai pass. From Chakdara I turned up the Uchnu Dara and arrived at Uch village, situated in fine, open, well-cultivated country, with hardly any jungle for miles round; paddy is grown here in great abundance. The inhabitants are all Pathâns. In fact, throughout the Swát district all are Pathâns of the Yusafzai sect, wearing the same style of clothes as are worn in Peshâwar and speaking the Pashtu language. There are no courts throughout the Swát district. If a man is caught stealing he is killed by the owner of the stolen property, if possible, on the spot; but if he escapes to another village he may not be molested. In the case of a murderer, or one who has taken life in a blood-feud, if hard-pressed by pursuers he can take shelter in the house of a *Mullâh* or *Saiyid*, and is safe for the time until he can make good his escape to another village.

9. Rice is the staple food of the people about here; but there are other kinds of grain, such as maize, wheat, barley, and several kinds of pulse. Oil also is a local product; but salt is imported from Peshâwar. There are no salt mines or pans in the country as far up as Gilgit and Kashkár, and this commodity rises in value with the distance from Peshâwar; in places being so dear that it is bartered against twice its weight of ghee. Sugar is also imported from Peshâwar; but the cultivation of sugarcane has now been commenced in the lower portion of the valley, as I saw a small plot of it near Khár-Batkhela. Horses are common. They are, however, all imported from Peshâwar, none being bred in the Swát valley. Sheep, goats, cows, and buffaloes are in great abundance; fowls also are plentiful. The river abounds in fish; one kind in particular, red in colour and averaging about 5lb in weight, being very good eating. During the day these fishes leave the Swát river and are caught in great abundance high up the tributary streams. During the heat of the day they may be seen ascending the streams, going with great rapidity near the surface of the water, and absolutely springing up the occasional falls, some of which are fully ten feet high. They are caught chiefly at the tops of these falls in nets set across the stream.

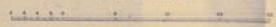
The men, as a rule, are a weakly race, perhaps owing to the rice diet on which they subsist.

10. Different kinds of coin are current in the valley—English, *Muhammad Shâhi*, and *Gunda*. The English coin was formerly undervalued, but now it is valued at its full worth; while the *Muhammad Shâhi* and the *Gunda* have become depreciated, the rate of exchange being variable. Counterfeit coin of local manufacture is occasionally met with. As a rule, however, the use of coin is much restricted, most transactions being carried on by barter.

11. Every village in the Swát valley gives some ground rent-free to poor Afgháns called *Malatárs*, in return for which their services are called into requisition when any fighting is to be done, and they must obey. If the dispute be only between two villages of the same tribe, Pathans and *Malatárs* both combine and take the field; but should assistance from any other tribe be asked, the *Malatárs* only are sent, accompanied perhaps by one or two Pathans. These *Malatárs* are armed with muzzle-loading rifles, and they manufacture their own ammunition. The caps cannot resist the effects of damp weather unless very carefully protected and kept in dry places. After a couple of months they are generally useless, the detonating composition having either become damp or dropped out altogether. The powder is of a superior quality.

SKETCH TO ILLUSTRATE THE MULLAH'S EXPLORATIONS IN 1878.

Scale 1 Inch = 8 Miles.



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Surveyor General's Office, Calcutta, February 1879.

Photozincographed at the Surveyor General's Office, Calcutta.

12. Ráhmat Ulla Khán, an inhabitant of Dir in Malezai, is the *Khán* or chief of all the villages in the Uchnu Dara, and levies a tax on every house. The villagers pay no rent or other tax; the soil is their own. Ráhmat Ulla Khán settles all disputes between contending parties in the valley. He obtained this influence over them by force, being a powerful chieftain and having a great number of followers and dependants.

13. Leaving Uch on the 18th, I returned to Chakdara and went on to Ramora Sáhibzádgán, or "Ramora occupied by sons of pírs or holy men," called thus to distinguish it from another village of the same name about half a mile west of it near the road. Ramora Sáhibzádgán is on the right bank of the Swát river.

14. On the 19th I arrived at Garidagi village, situated on the right bank of the river and close to it, in the *pergunnah* of Nikpikhel, passing on the road the village of Parrai. The road in this march was good and practicable for laden horses; the ascents and descents, though numerous, were not steep. On the left the hills were in close proximity; while the river flowed close by on the right. The base of the hills is covered thickly with a thorny shrub growing to a height of about six feet, which bears large clusters of a small berry considered by the natives a great luxury. The wood of this shrub is yellow and highly prized; when pulverized it is taken internally as a medicine, and considered most efficacious in removing pains in the back and in curing sores and eruptions of every description. The local name is *kuáre*.*

15. From Garidagi I marched to Hazára, and thence turning up the Nikpikhel valley, reached Sarsenai village, where I halted for a day. On the 22nd I went up the valley as far as Tighak and returned to Sarsenai. I wished to explore the valleys branching off to the right from the main valley; but as there was a feud amongst the people, and fighting was going on at the time, I was dissuaded from carrying out my project, as in such an unsettled state of affairs it was more than likely I would be robbed.

16. On the 23rd, leaving Sarsenai, I returned to Hazára, and proceeding thence to Tutke, turned into the Sibujni valley and halted at Kararai. Titles appear to be assumed at pleasure in some of the valleys in the Swát district. Khán Saiyid Ahmad Sháh, native of Sarsenai, has assumed the title of King of the Sibujni valley, and levies on all the villages in the valley a tax of one-tenth of the produce of every kind of grain, and a small percentage on the live-stock. This tax, called *ushur*, is properly speaking rather a voluntary contribution or offering than a tax. Should there be no King or *Khán*, the *ushur* is distributed amongst the poor. The word is from the Arabic and signifies "God's property." The King's servants are called *Ushurain*, as they collect the *ushur*.

17. Three or four years previous to the death of the Akhúnd of Swát, he expressed a wish that Saiyid Ahmad Sháh should be nominated king over the whole of Swát; the latter, however, and other influential men, would not agree to this proposition, but advised the Akhúnd to allow his eldest son to assume the reins of government. This again the Akhúnd dissented from, saying that he himself was a *fakir* and his son must be one also. The residence of Saiyid Ahmad Sháh is in Shangwatai in the Sibujni valley.

18. On the 24th I explored the Sibujni valley, and whilst traversing up it, I saw a good deal of fighting going on; every now and again coming across small parties of armed men wandering about with the purpose of plundering each other's villages, or of attacking other parties bent on plunder. When questioned by these men as to my destination, I answered that I was going to visit Ajab Khán, having ascertained beforehand that he lived at the extreme end of the valley, as I heard he had a very fine horse for sale. The Khán was annoyed when, on reaching his house, I informed him on what errand I had come, as the horse was a great favourite, and had carried him out of more than one perilous situation in the fighting now going on. The horse had, however, lately hurt his hoof, and when I showed the Khán how to treat the hurt he was much pleased, his annoyance passed away, and we became very friendly. Having gone on up to the extreme end of the valley (where figs in great quantities are collected) I returned to Tutke, and thence, continuing my journey, I arrived at Kuza Durushkhela, a large village on the right bank of the river, containing several *banias'* shops, where supplies were plentiful. *Banias* are here called *paráchas*.

19. Crossing by a *jála* to the left bank of the Swát river near Durushkhela, I arrived on the 25th at Barshin village. On the 26th I reached Churrai, which is the end of the Swát valley; here, about a mile and a half broad, or nearly the same breadth as at Issar where I first entered it. Intermediately the valley is from three to four miles in width, except in a few places where it contracts to less than a mile. The hills about Issar on both sides of the valley are covered with forest trees; but a few miles higher up these disappear, giving place to fruit trees and other smaller trees. At Churrai, grapes, walnuts, apricots, mulberries, and currants are in great abundance, and of superior quality. Two miles beyond Churrai is the boundary between Swát proper and Kohistán. The Swát valley contains two large villages—Thána and Mingraura—which have both large bazars containing *banias'* shops, some of which belong to Hindustáni and Punjábi *banias*, and other shops, such as bakers, fruiters, *mahájun* and *bazáz* (cloth merchants), *bisáti* (small general dealers), blacksmiths, &c. A number of Hindus reside in these large villages. They dress in keeping with the custom of the country, but retain the same prejudices of caste and forms of religion as in Hindustán.

20. On the 27th I arrived at Cham, a village in Kohistán, having crossed to the right bank of the river by a bridge near the Darál Dara. The river is here confined by large

* This is apparently the Barberry (*Berberis aristata*), which is also found in the lower ranges of the Himalayas.

rocks to a bed so narrow that an active man might leap across. On the road to Cham, which for miles passes through jungle with a few villages here and there, I met with a slight adventure near the boundary. I wished to halt under the shade of some fine large trees which I saw before me close to the roadside; and on nearing them, I perceived about half-a-dozen men seated, who, on seeing me, rose and invited me into the shade to lie down and rest, offering to shampoo me as I must be fatigued. Not liking their looks, I declined their services, and was proceeding on my way, when they proposed to relieve my servants of their loads, and carry them on to the next village for me. They became violent and were forcibly dragging the loads from my servants, when I told them, in a determined manner, that if they did not desist, I would shoot them, it being a matter of indifference to me that their numbers were greater than mine, I had only two men with me, as I was well armed. The sight of my pistol showed them I was in earnest, so they desisted and I went on; but after a time I saw them again on the road ahead of us, they having preceded me by a short cut. However, they allowed us to pass quietly, evidently unable to quite make up their minds to attack us.

21. On the 28th I marched to Gujar Bánda, a small hamlet of about half-a-dozen houses, the road keeping close to the river, which is here called the Kohistán river. The valley narrows on entering the Kohistán territory, and is covered with dense forests of fir, pine, and oak trees, as are also the hills which border it, up to their summits. The royal pine is the most plentiful, and is of very large dimensions. These trees are highly valued as timber, the other kinds not being of much worth in that respect. The leaves of the oak are used as fodder for goats, &c., and the wood for fuel. I noticed no rhododendrons; but walnuts, apricots, and apples grow wild in the forest, as do also grapes, but not so plentifully as the former. Currants form a perfect jungle; the undergrowth in some places consisting chiefly of them.

22. Six miles from Churrai, near Náwe Barániál, the Swát river divides into two streams of about equal dimensions, one from the Kalám direction, which I followed, and the other from the Darál valley. The Darál valley is famed for its ghee, as for three months and upwards *Gujars* take their cattle into the valley, where there is abundance of pasturage. They go up about the end of June and return by the end of September.

23. On the 29th I arrived at Utrot *viâ* Kálám. Kálám is situated between two rivers, one flowing from Utrot, and the other from Ushu; and to get to it I crossed the Utrot river by a good wooden bridge, passable for laden horses. From Kálám I followed the left bank of the river to Utrot, crossing midway, by another substantial wooden bridge, a rapid stream, called the Bahandra. On nearing Utrot, I crossed by a third wooden bridge, a very large stream called the Gabriál, which is the main source of the Swát river.

24. The valley along this day's march is rather narrow, except for about three miles near Kálám, where it opens out. The valley and the hills on both sides are thickly covered with trees of enormous size. I fancied that I had never seen such forests of huge trees as those I met with when first entering the Kohistán territories; but beyond Kálám the size of the trees surpasses description. The species are the *Ranzro* (the royal or black pine), which is very valuable, each tree being worth Rs. 150 to Rs. 250 in the Pesháwar market, according to size; the *Ucher* and the *Piwich* (a species of deodár). Apricots, walnuts, apples, and grapes are found here and there. The oak grows only on the hills, and is comparatively small. Indian-corn, barley, and wheat are grown plentifully in this valley. Kálám is a large village, containing about 1,000 houses and a *masjid*. There are about 20 water-mills here for grinding corn, and they have a strange custom of roasting the grain before grinding it. The inhabitants are generally wealthy, being possessed of large herds of cattle, and exporting large quantities of ghee to Pesháwar.

25. The Gabriál river flows from a glacier about six miles distant from the road, and receives its name from the village of Gabriál, situated about three miles up-stream, and containing about 20 houses on both banks of the river: the valley is occupied by *Gujars*. The village of Utrot, distant about half a mile from the wooden bridge over the Gabriál, contains about 700 houses. It has no regular bazar, but there are two or three shops of *Paráchas*, who sell supplies to travellers. There is also a large *masjid* in the village. Utrot is celebrated for its ponies. Musk-pods are also procurable here, as well as throughout the whole of this Kohistán. The village of Gabriál is subordinate to Utrot.

26. I was delayed at Utrot for two days, on account of heavy snow in the pass which I had to cross in the next stage, and did not leave till the 2nd July. For the first three miles the road was level, the Gabriál river flowing about 300 to 400 paces distant on the right hand, while the foot of the hills was distant about 100 to 200 paces on the left. The road crosses the Sajáun nadi, a tributary of the Gabriál, by a wooden bridge strong enough for beasts of burden. All this portion of the valley, covered with grass, is used as pasture-land by the inhabitants of Utrot.

The road then leaves the river and turns up the hills on the left by a steep ascent of about a mile and a half. The soil here is clay, and the hills are covered with tall forest, the fallen leaves lying thickly on the path, making the ascent very slippery. At the top of this ascent an open glade in the forest is reached—a plateau about 500 paces in length and 400 in breadth—which is used as a grazing-ground by the Utrot people in July and August, when the snow melts and the grass springs up. At the upper end of this plateau there was water in a small ravine to the left. From here the road again ascends by a gentle slope for about a mile and then by a steeper ascent, till the first crest of the range of hills known as Sajáun, is reached.

27. At this time a famine was raging throughout the valley, and numbers of men and women were seen going up the Sajáun hill in search of a wild vegetable, which they were then using extensively as food. This vegetable grows in tufts about four inches high from the ground, and has small tapering leaves: it is cooked before being eaten.

28. From the first crest of the Sajáun the road winds along the face of the hill for about a mile, having no great rise or fall, the Sajáun nadi flowing beneath the road to the left; then there is an easy ascent of a mile and a half to the second crest, along which ascent snow was lying knee-deep, but rapidly melting; probably by the end of July the hill-top would be quite free from snow. There is no forest between the two crests of the Sajáun, but as the snow melts grass springs up. The descent on the other side is gentle for about 2½ miles to a *ziárat* and *masjid* near a running stream, where I put up for the night. On this face of the hill the snow lay deeper, being about four or five feet deep near the summit, and decreasing with the descent till it disappeared near the *ziárat*. The valley, which from the top of the pass looked broad and open, proved to be otherwise, as the subordinate spurs from the bordering hills on either side closed in on it much more than was apparent from above. In its widest part it never attained a breadth of more than one or two hundred yards, and that only for a very short distance; its general breadth was much narrower, in some places being only about 40 paces. Grass grows abundantly on the banks of the stream, and the inhabitants of Lámuti send their cattle up here to graze.

29. On the 3rd July I started from the *ziárat* for Lámuti, the road descending all the way down the valley, the sides of which were clothed with tall forest trees, the *ranzro*, *wcher*, *piwich*, &c. Patches of cultivation were met with about a mile and a half from Lámuti, but they were so small that I estimated them to aggregate not more than 40 acres; the cultivation belonging to Lámuti lies chiefly on the other side of the river.

30. General scarcity seemed prevalent in this part of Kohistán. Grain was procurable with difficulty even at the rate of 2½ seers per rupee, and that of the coarsest kind; Indian corn, wheat, and rice being quite unprocurable, even in the largest villages. Whenever I made enquiries at any village with a view to purchasing grain, I was always told there was none to be had in the place, but that I could procure any amount of supplies at the next village. On reaching the next village, of course it was the same story again, grain being so scarce that none wished to part with the little they had at any price.

31. On the 4th July I left Lámuti and retraced my steps to the *ziárat*, and on the 5th arrived again at Utrot. On the 6th I left Utrot and encamped in the valley on the banks of the stream between that place and Kálám, being compelled by weakness, caused by want of food, to make such a short stage. When leaving Lámuti I had only two loaves, one of which my companions and myself ate at the *ziárat*, and the other at Utrot. I did not succeed in obtaining either corn or goat at Utrot; grain being unprocurable, and live-stock being all up in the higher valleys grazing; so, after two days with very scanty food, we passed the third day without tasting food at all. On the morning of the 7th July we pushed on towards Kálám, and on the road were fortunate enough to meet a man driving five or six goats and a few cows or buffaloes, towards Utrot. I bargained with him for a goat, paying about ten times the usual value in years of plenty, and, leaving the frequented road, retired to a secluded spot to slaughter the animal and cook some meat. Although no human being but ourselves was at first visible, yet no sooner was the meat being cooked than some 20 half-starved miserable-looking men collected round us. On my explaining to them that we were travellers who had tasted no food for two days, and that the meat we now had was barely sufficient for ourselves, they said they would be content if only the bones were given to them. I accordingly distributed the bones and some small pieces of meat amongst them, and carefully tying up the remainder, departed for Kálám. Here I put up in the *masjid*; and the *Imam* of the *masjid*, a native of Swát, was persuaded by my entreaties and the offer of a high price to sell me a small quantity of corn. Under cover of the darkness of night this was ground and taken to the bank of the stream to bake. I had some extra loaves baked for use on the following day; but these, with the remainder of the meat, although carefully tied up and placed under the head of one of my companions at night, was stolen whilst we were sleeping. Grain was imported from Swát on account of the local scarcity.

32. I halted for four days at Kálám, partly to collect supplies, and partly to enable one of my companions who had a sore foot, to recover. Having collected some provisions, but finding the man's foot no better, I started for Ushu on the 12th July, leaving him to follow me in a few days if he could do so, otherwise to return home. While at Kálám I made enquiries about the road to Kashkár, which place I had been instructed to visit; but was told that the snow on the passes was unusually deep this year, and it was believed that they would not be practicable before the end of July. I was told by the oldest inhabitants that they never remembered so severe a winter before.

33. The tract of country between the village of Churrai in the Swát valley and the villages of Utrot, Kálám, and Ushu is known as the Kohistán of Swát.* It was formerly

* The Mullah has oddly omitted to give the name of this tract, which comprises one, if not more, of his Kohistáns, and which is called Bashkár. The inhabitants (Bashkáris) talk a peculiar and difficult dialect of the so-called Dard group of languages. The salutation is "salaam," and the reply "badbadia" (you are welcome); then follows the usual enquiry "Jor tu? Khairat tu? Balim tu?" (are you well, &c.). In some villages the Bashkáris live in houses built up of pine logs, notched near the ends to make them fit into each other where they cross, and I take it, are similar to the dwellings of the Kaffirs and of the inhabitants of the Gurais valley in Cashmir.

The Bashkáris wear grey homespun woollen clothes, with the rolled cap of Gilgit, Yasin and Gurais, and, like the inhabitants of those places, instead of shoes they use long strips of goat's skin wound round and round their feet and

subject to Swát, but from increase in its population and consequent strength, it has now become independent. There are three Kohistáns between Kashkár and the Indus: the first is the Indus Kohistán, comprising the villages of Kolai, Pálas, Patan, Jálkat, Seo, &c., and containing the largest population of the three. Its inhabitants are well-built and powerful men, of a fair complexion, and dress themselves in coats and trousers somewhat resembling the English fashion; only *Mullahs* and *Saiyids* wear turbans, the rest of the people wearing caps. The second Kohistán is that of Swát, which somewhat resembles the first. The third is the Kohistán of Malezai, containing the villages of Tal, Lámuti, and Patrák, the inhabitants of which do not resemble those of the other two, their complexion and dress being both different. The tract of country between Tal, Lámuti, Utrot, Kálám, and Ushu on the one side, and Kashkár on the other, contains no permanent villages, but is visited by *Gujars* during the summer months only for the purpose of grazing their cattle.

34. The road from Kálám to Ushu is nearly level, there being no great rises or falls on the whole march. Starting from Kálám the Ushu nadi is about 1,000 paces to the right of the road, the base of the hills being from two to three miles to the left; but about a mile further on, the hills close in on the river, and the road skirts their foot to Ushu. The hill-sides are covered with tall forest trees, and about a mile from Kálám there is a patch of ground about 100 chains long cleared of jungle and cultivated. Walnut, apple, and apricot trees abound in the forest between Kálám and Ushu; and during the prevailing scarcity the fruit was plucked and eaten by the people before it became ripe. About a mile south of Ushu is the place where the *bánda* or winter quarters of the inhabitants of that village was formerly situated; but avalanches had completely destroyed it, and the road below was blocked up by trees hurled down by their force. I was also informed that the course of the Ushu nadi had been blocked up for several days until the collected waters forced their passage through the barrier of snow. All along the road from Ushu to Kána, with the exception of a few miles along the Indus, avalanches were of daily occurrence.

35. At Ushu I found my servants, whom I had sent on with the merchandise from Pesháwar. Here also I again made enquiries about the road to Kashkár, but was told that the snow was lying deep on the pass, and there was no chance of crossing it before the end of July, if then even. Ushu village is situated on the right bank of the stream on the hill-side above the road, only about 100 yards from the river, and contains about 500 houses. From here a road crosses the nadi, and with a general bearing of 75° goes, *viâ* the Matiltán or Matákán Kandan (or pass), to Gabriál village in Kándia. I was informed that a strong person can perform the journey in two days, but the road is very difficult. I was also told that only the high range of mountains crossed by the Matiltán Kandan intervenes between Ushu and the Kándia valley in which Gabriál is situated, and that there are no villages either along the road or on the whole of the intervening mountain range. The *parácha*, with whom I had contracted for the carriage of the merchandise, brought it as far as Ushu on mules, &c.; but finding that the road in advance was not practicable for beasts of burden, he employed men for its carriage thence.

36. On the 13th July we all left Ushu in company, and after proceeding about 1,400 paces we crossed the nadi by a wooden bridge which is practicable for laden animals. Close below this bridge a stream, coming from a bearing of 110°, falls into the Ushu stream, and from here the road ascends for about a third of a mile, when it again becomes level. On the flat here, are some cultivated fields and a water-mill belonging to Ushu. About six miles from this place a stream flowing from the Paloga Kandan falls into the Ushu nadi. The breadth of this tributary was only about 30 paces, and I crossed it by means of some large trees which had fallen across it. The road for these six miles is fairly level and generally practicable for laden animals; but when I traversed it I found it difficult on account of the avalanches from the hills to the right which had blocked up the road here and there. Another road to Gabriál of Kándia passes up the Paloga stream, crossing the intervening ridge by the Paloga Kandan. This road, I was informed, was not so difficult as the one from Ushu. The hill-sides here are covered with tall forest trees; grass is also abundant, and in the warm weather the people of Ushu send their flocks here for pasture.

37. Proceeding about half a mile further, the road ascends for quarter of a mile; the river being about 200 paces to the right, and then for 2½ miles it runs nearly level. Snow, to the depth of about a *foot*, was lying on this part of the road, but was fast melting away. Two and a half miles further on, the road divides, one branch going off at a bearing of 340° to Láspur and Ghizar in the Kashkár territory, the other leading over the Palesar Pass to the Kándia valley. I had come so far, leaving the two roads to the Kándia valley already mentioned, with the intention of sending on my men and merchandise along this third route

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lege, leaving the toe and heel free. They also use knitted gaiters of black goat's hair, similar to those used in the Safid Koh of Afghanistan and in Chuganistan. Battle-axes, called "tong," and broad-headed spears, called "shál," with very long matchlocks, are used in battle, but the people have very few knives.

Bashkár makes a yearly present to the ruler of Yasin as a token of friendship. The country comprises the following forts or villages and the adjacent lands, viz. Thal, Lámutai, Kalkot, Birkot, Kaj-Biár, Pátrak, Ushu Kálám, Uthrot, Aráni, and Láikot.

The stages from Yasin to Ushu, distant about 100 miles, are as follow:—(1) Yasin to Pingal on the Ghizar river, then Gharza; (2) then comes an easy pass over the great watershed that separates Yasin and Gilgit from Tangir and Darcyl, below which is Uria; (3) an encamping ground in the pine forest; then a grazing and sheep-penning place named Khush Bánád; (4) ("Bánád" means "Bánda," or shepherd's hamlet in the Bashkári language); then Ushu. The distance from Ushu to Larkot is about 22 miles. The Bashkáris have the reputation of being hospitable and of good disposition. They are Sheahs, whilst the inhabitants of Swát and of the Kándia valley are Sunnies.

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to it, and of going myself by the left hand road into the Kashkár territory. My men had remonstrated at my not taking the shorter routes to Kándia by the Matiltán Kandan or the Paloga Kandan, not knowing my secret intentions; but I had explained to them that my reason for coming so far was that the third road, *viâ* the Palesar Kandan, though circuitous, was comparatively easy, as it crossed the intervening range at a lower elevation than the former roads.

38. I encamped for the night where the roads divide, and here I found some *Gujars* who had arrived there that day with their cattle. They came to me in the night and asked me who I was, so I told them that I was a *Saiyid*, and was going to Gabriál in Kándia for timber, having chosen this upper and circuitous route because a number of other *Saiyids* and timber merchants had been over the lower routes before me, and timber was now becoming scarce in the lower end of the valley; wherefore I wished to reach the Kándia valley at its upper end, and traverse its whole length, looking for suitable timber to fell. In the course of conversation I questioned the *Gujars* about the road to Kashkár, and was told that in other years the passes would have been open some 20 or 25 days later on, but that this year snow was lying so deep on them that they doubted whether the route would be passable at all this year.*

39. Finding it impossible to proceed to Kashkár, I left on the morning of the 14th July for Gabriál in Kándia. The Ushu valley is here about half a mile broad, and the road here leaves it to turn up the stream, coming down from the Palesar Pass, which stream was now frozen over, water being visible only here and there. The ravine through which the stream flowed was only about 50 paces broad, and the road for about a mile followed the left bank, gently ascending over the snow. Crossing the frozen stream to its right bank, I left the main ravine and turned up a smaller one to the left towards the Palesar Kandan; the head of the main ravine I estimated to be about two miles distant from the point at which I left it. For about 300 yards above the junction of these two ravines the water was not frozen over in either of them. Proceeding half a mile further up a very gentle ascent, I crossed over to the left side of the stream, and from here, for about a mile and a half, the ascent was very steep and was rendered more difficult by ice. The breadth of the ravine was about 100 paces; the hills on both sides being precipitous, and the road passed over the frozen stream. We were obliged to take off our shoes, and even then the way was so slippery that we had to dig out our foothold in the ice. The cold was very severe, and some of my servants, who had no stockings, wrapped strips of cloth round their feet as a protection. With the exception of a few trees of stunted growth,† about 10 or 12 feet high, on the side of the hills to the right, no vegetation was to be seen. After another half mile of difficult ascent we reached a *jabba* or lake, to the right of the road, about 4,000 paces long, and from 300 to 400 broad. This lake is the source of the Palesar stream, and seems to be formed only by the melting of the snows on all sides of it, as I noticed no stream entering it. The water was visible only in pools here and there, the lake being almost entirely frozen over.

40. By the time we had passed the lake the sun was setting, and I could see no place of shelter to protect us for the night from the snow, nor any fuel to light a fire with. My followers had for some time been murmuring at the hardships to which they were subjected; but I had incited them by threats and entreaties as occasion required. The dreary prospect now presented by the wide snow-fields which surrounded us, combined with the certainty of being obliged to pass the night under no better cover than the sky, made them despair of their lives. To beguile their fears, I proposed a smoke to refresh ourselves, but was appealed to as a Muhammadan to refrain from this forbidden luxury, when death was so near at hand. Although myself almost convinced of the truth of their assertions, that we could never survive the night, I kept up a bold appearance, as I saw no other means of escape but by perseverence. I told them I was in no way fatigued, and was determined to cross the pass and halt for the night at some comfortable spot on the other side. They urged the impossibility of crossing that night. While discussing the matter we were still proceeding, and presently I saw some black specks in the distance, to which I directed the attention of my followers and urged them to push on in that direction. We found them to be several rocks projecting out of the snow, and by going round to the lea side of them we obtained at least partial shelter. Here we partook of some dry flour to appease our hunger, and sheltering our heads under projections of the rocks, lay partly exposed to the snowstorm. Overcome by fatigue, however, we slept soundly till about 8 o'clock in the morning, and when I awoke I was delighted to find not a cloud in the sky.

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* The Mullah makes mention several times of the unusual amount of snow met with during this journey. The fall of snow in October 1877 throughout Cashmir, Gilgit, and the northern mountains of Afghanistan was greater than any remembered by the oldest inhabitants. At one place between Gilgit and Srinagar I was informed that it lay level with the top of the pines. It closed the passes for months, and even whilst I write this note, in January 1880, the remains of the avalanches of that year still block up some of the Cashmir valleys. The destruction of forest has been enormous throughout the north-west of Cashmir, and at Jelalabad I was shown the wreck of groves of trees on the banks of the Cabul river torn down by the flood, which, even as early as the spring came, rose to a most unusual height.

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† Most probably the cypress or "Cupressus Porulosa," which grows at a greater altitude than any other tree or shrub, and has a range greater than any species of vegetation, except perhaps the grasses, for it just manages to exist in the heat of summer at 6,500 feet and at 1,450 feet, when it is a twisted, unhappy, gnarled, and knotted looking snag. It passes most of its days either beneath the snow, or in a temperature far below freezing.

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I called out to my companions to behold the sun shining again with all its lustre and to prepare for the march.

41. Starting again from these rocks on the 15th July, for about half a mile I found the ascent easy, but then followed a very steep climb of some 500 feet; the snowstorm followed by a clear hard frost having added considerably to the difficulties of the ascent. With the exception of one coolie from Ushu, all the men had falls—some of them several—but fortunately without accident. The Ushu men all had goat-skin wrapped round their feet, covering all except the toe and heel, and reaching some way up the leg, which kept them warm and prevented them from slipping. As we had no such protection, I tore up a new blanket into strips and tied them round our feet in the Ushu fashion. After toiling up this steep ascent we passed over a comparatively easy rise of about half a mile, followed by an almost level stretch of 1,200 paces, so easy that a horseman might gallop over it. Another rather difficult climb of about 400 paces took us to the top of the Palesar Pass. The width of the pass, from the rocks where we had passed the night up to the top, was about 200 to 250 paces.*

42. From the top of the pass we saw a very steep descent into the Sumi Dara, and I was looking along the mountain sides for an easier way of getting down, when I was told by the Ushu men that there was only the one way down which lay before me, and that right and left were large glaciers and snow-beds. They told me that nothing was easier than to slide down the steep descent before us, and we accordingly prepared to do so. The Ushu coolies commenced first. Each man sat down in succession at the edge of the steep, stretched out his legs, and with a staff in one hand, and holding his load to his side with the other, saluted the party, and in a moment slid down to the bottom. The motion was so rapid that in its course the outlines of the men's figures could not be distinguished. I and my companion were the last. We were told that, if we were afraid to attempt the whole descent at once, we could break it off where we liked by planting our staves in the snow across our feet. I tried to follow their directions as well as I could; but not being used to such a novel process, whenever I tried to halt my staff always got between my legs instead of across my feet, so that I came up astride of it. However, we all got to the bottom in safety.

43. From the bottom of this steep descent the slope for 2½ miles was gentle down to a stream flowing from a bearing of 270°. Another stream formed just below the steep descent flowed down in the direction we had travelled, and joined the first-mentioned. This latter stream flows under the snow nearly the whole distance to the junction. At about 200 paces above the junction the sound of flowing water is first heard, and about 30 paces from the junction, the stream emerges from under its snowy cover. Proceeding along the right bank of the stream for a mile and a half, over a road originally pretty level, but now made so uneven by avalanches from the hills on the right that abrupt rises and falls of 40 to 50 feet had to be passed over, a stream coming from a bearing of 360° from the Máhr ravine joins the stream we were following at about 40 paces to the left of the road. The Ushu coolies informed me that, about two miles from this junction, the Máhr ravine divided into two—the one to the left being called the Máhr and that to the right the Hag—and that footpaths up these valleys led across the range of mountains to Andarp and Ghizar in Kashkár. The journey is said to take about two days; but the route is not practicable for beasts of burden: it is not generally known, and very seldom travelled. From here trees of stunted growth were again met with, and after the melting of the snow grass springs up; the inhabitants of the valley below bringing up their flocks and herds for pasture.

44. A mile and a half further on, another stream, issuing from a glacier about a mile to the right, crosses the road and falls into the stream which we were following. This portion of the road is interspersed with large boulders, and is impracticable for beasts of burden. On the opposite side of the valley I saw some cattle grazing, and a small *kacha* house, but no human beings. The cattle, I afterwards found, belonged to some *Gujars* whom I met lower down the valley. Some 1,600 paces lower down the road ceased, and was seen to continue down along the opposite bank, but there was no bridge across the stream, which was not fordable. On the other side I saw some *Gujars* to whom the cattle before seen

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* The Mullah was now crossing the great watershed separating the Yasin and Gilgit countries from Bashkar, Darcyl, and Tangir, near to a point where the range turns to the southward. The ridge rises abruptly in great scarps from the very banks of the Indus at Booni in the east, and extends westward as far as the Kunar river. To the east the higher points have some 15,000 feet altitude, and they gradually increase in height to near 20,000 feet towards the west. The spurs from the central backbone extend nearly 20 miles northward, decreasing very imperceptibly for some 18 miles in height, when they suddenly dip into the Gilgit valley. The appearance of the range from near the extremity of one of the Gilgit spurs is that of a sea of wavelike ridges and points, all nearly of the same height and very similar to each other in appearance. The slopes are easy and down-like, and much frequented by Gujars in the summer. There are many lakes formed by glacial action, and in some places glaciers of considerable magnitude, but these are not generally formed by mountains of a less height than 18,000 feet. The snow line is situated at about 16,000 feet, but it lies in patches below that altitude in sheltered positions. It may be stated that there is no snow whatever at 14,500 feet during the autumn.

The range is a very important geographical feature, for it separates the rainless tracts of Gilgit, Hunza, and Yasin to the north, from the well-watered countries of Bashkar, Swát, &c., to the south. To the north of this ridge the vegetation is limited to a narrow belt, the general altitude of which may be set down from 9,500 to 12,500 feet, in which grow thinly scattered Pinus Excelcis, Abies Smithiana, Cypress (Cupressus Torulosa), birch, &c., while to the south the forests are described as magnificent and with a profusion of deodar. It is probably this very range that catches all the rainfall which would otherwise pass over to the arid tracts in the north. In another particular also this range has an importance which should not be overlooked, for, broadly, it is the great boundary line of the Shiah and Suni religions. To the north there are very few Sunis, and to the south, except in Bashkár and Kándia, no Shiahs. I have never yet been able to learn that this range has a name, but I think that the western extremity, where it abuts on the Kunar valley, may hereafter be identified with the Hindu Báj mountains of the Afghans.

belonged, and I called out to ask them by what means we could get across. They told me that a bridge was always built at this spot later on in the season, but it was carried away during the winter, and that my best plan would be to retrace my steps to the last junction, where there was a bridge over one branch and the other branch was fordable.

45. The evening was closing in, the sky was overcast, there was a slight drizzle already falling, and I had noticed no place of shelter on the road we had passed, in case of its becoming too late to cross over at the upper bridge, so I determined to halt where I was for the night. To the right of the road was a large rock hollowed out a little on one side; and in this little cave we deposited our merchandise and spare things for protection from the rain, two of my servants depositing their arms there also. Some 40 paces higher up the road were a few trees under the shelter of which myself and companions proceeded to cook our dinner, but before it was ready the *Gujars* gave the alarm of an avalanche, and we fled for our lives higher up the valley. The avalanche came down with such force that the ground in the valley was torn up for a great distance, and enormous quantities of earth and *debris* were thrown into the bed of the stream and even across it; the stream being entirely filled up to a height of 30 or 40 feet and covered with masses of fallen snow. For two hours stones and blocks of ice continued rolling down in detached masses; but when quiet was at last restored, we lit a fire and prepared to pass the night as best we could. One of the *Gujars*, however, at the request of some of my party, crossed the river on the snow lately fallen and conducted us all across to their camp, treating us very hospitably and giving us a quantity of milk and ghee. In the morning I asked their advice about the property which I had stored under the rock and which was all buried under the avalanche. I told them that I was a *Saiyid* and that I had purchased all this property by means of loans from *Mahajans* in Peshâwar for the purpose of trading in timber, and that unless I could recover it and pay back my debts I was a ruined man. They sympathized with my trouble; but told me that it was beyond the power of man to remove the mountain of earth and snow which had fallen over the place where the property had been deposited. There was only one chance, to wait patiently till the ice and snow melted and then try and recover it by digging; but even here success would be doubtful, as the property might have been deeply buried, or have been thrown into the nadi by the force of the avalanche; and in all probability it would decay and become worthless before it could be recovered.

46. Despairing of the recovery of our merchandise and provisions, I discharged the Ushu coolies, and purchasing some ghee from the friendly *Gujars* to serve as food, should we be unable to obtain other provisions, we left the place on the morning of the 16th July. This valley into which we had descended from the Palesar Pass is known by the name of the Sumi Dara as far as its junction with the Maidân Dara; it is uninhabited, and only visited by *Gujars* with their cattle. Proceeding from where we had spent the night about two and a half miles along the left bank of the nadi, I crossed the Ding stream by a wooden bridge about 20 paces long. Up the valley, whence this stream issues, we saw some *Gujars* going with their cattle. Up to this point the Sumi valley had been fairly open, but from here to its junction with the Maidân valley it is narrow and difficult to traverse on account of the road being covered with large rocks. Tall forest trees, such as were found in the valleys on the other side of the mountain range, now began to appear on the hill sides. Three and a half miles further, another stream from the right joins the Sumi nadi; near this junction the place was infested with gnats, so much so that to keep them off we were obliged to hold twigs and small branches of trees in both hands to brush them away. Proceeding 2,700 paces further, another stream from the left crosses the road and falls into the Sumi; the valley here was comparatively open and level and covered with large forest trees, and as evening was drawing near I halted here for the night.

47. On the 17th July, after travelling some three and a half miles, we reached the junction of the Sumi and Maidân rivers, about 200 paces to the right of the road, having passed two or three small *kucha* huts built by *Gujars* as shelter for themselves and their cattle during the night while in the vicinity. Throughout the Sumi valley I had met no one but *Gujars*. These people are nomads; they possess no lands, and their only occupation is tending their cattle.* At this junction, however, I met two men from Bajâur who had come to purchase musk-pods for the Peshâwar market.

48. I now turned up into the Maidân ravine, as it was said to contain fine timber in which I still pretended to be very much interested. I persuaded my men that although on account of the loss of my property I could turn my knowledge of the timber localities to no immediate account, yet I was determined to return and make a profitable use of it. Half a mile from the junction I came to a bridge known as the Sumi bridge, a portion of which had been washed away by the stream, so that I was unable to cross it and follow the usual route up the valley along the other bank, which appeared to be pretty level and practicable for laden animals. I therefore continued my course along the right bank over a little frequented and very difficult path for about a mile and three-quarters to another bridge, known as the Maidân bridge. This path for the first portion is a steep ascent, and for the latter part a gentle descent. The roadway in some places had been almost entirely carried away by

* The Gujars extend from the Nerbudda River in India, as far up as Yasin and Chitral and through Cashmir and Swât. The Hindustani Gujars are generally Hindus, but in the mountains of northern India are Mahomedans, who, in Yaghistan (or "independent territory") talk a language of their own, and have many peculiar and interesting customs.

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avalanches, and it was very difficult to pass over such portions: the highest portion of the path was about 1,500 feet above the river. The Maidán bridge is practicable for beasts of burden, and the path along the right bank, which we had followed, here meets the proper road, which crosses over the stream by this bridge. For a distance of about three-and-a-quarter miles the road is nearly level, running along a flat for the first-half mile about 40 paces distant from the river; the foot of the hills being about 500 yards distant. The road then skirts the bank of the stream and the hills close in on it, till near the junction of the Záhar and Maidán ravines the road is close to the base of the hills. The stream has little or no fall along this portion of the route, and the current is consequently very slow. The hills on both sides are covered with magnificent timber.

49. Having satisfied ourselves concerning the timber, my men urged me to return, but I pointed out that we had no provisions except the ghee we had purchased from the *Gujars* the previous day, and that we could not reasonably expect to procure supplies in the lower portion of the valley, as the majority of the inhabitants had migrated to the upper portion for the warmer season. As the summer hamlets of the people were not much further up, my men consented to follow me.

50. The Záhar stream, coming from a bearing of 225°, crosses the road and joins the Maidán nadi about 100 paces to the right of it. There was no made bridge over the Záhar, but some large trees which had fallen across it served as a bridge; while the bed being broad and shallow, cattle can easily ford it. Both the Maidán and Záhar valleys are occupied during summer by settled inhabitants of the valley below, who take up their cattle to graze. Crossing the Záhar we proceeded along the Maidán river about six and a half miles further, along a pretty level road, till we arrived at another tributary stream joining it from a bearing of about 90°. Up this minor valley a road goes across to the Tangir valley to the east, which road is said to be much easier than other routes to that valley, and is much frequented. It is said to be about two and a half days' journey from the Maidán to the Tangir valley by this road. The Maidán valley about here is broad and open, and some 20 houses and huts are scattered about on either side of the stream. I halted for the night here, a short distance below the junction of the minor stream.

51. On the following day (the 18th of July) I was unable to bear the fatigue of walking from the effects of fever and dysentery, from which I had been suffering for the last two days. I therefore rested for the day and sent out my servants in search of provisions to the houses in the neighbourhood, but they succeeded in obtaining only some cheese.

52. Starting again on the 19th July we crossed to the left bank of the stream a little above the road leading to Tangir. The name of Maidán is here dropped, and the valley higher up is known as the Doga Dara. Here I told my men to go again in search of provisions while I would push on to a hut I saw higher up the valley, also in search of supplies, and to endeavour to obtain some musk-pods which were reported to be procurable there, and for which my Pesháwar *mahajan* had made special request. After proceeding nearly a mile, a stream from the left joined the nadi, and here I found a hut; but the woman who was there told me she had neither flour nor corn to sell, while as for musk-pods, the Bajáur men had bought them all up. These were the men whom I had seen in the Sumi valley, and who, hearing that I also was looking out for musk, had pushed on before me lest I should spoil their bargains. The woman, however, sold me some fresh milk and some buttermilk, and told me that her husband was out shooting, that she had heard the report of his gun, and if successful, he would soon be returning with his game. Telling her that I was in a hurry to return and could not wait, I said I would follow her husband and meet him on his way homeward. The valley now narrowed considerably, and after going about two and a half miles higher up, over a rough and difficult path practicable for foot passengers only, I came to a stream from the right: another walk of half a mile took me to the head of the valley. From here the road ascended to the ridge, but being covered with snow, its direction was not traceable. I, however, learned lower down that this road, after crossing the mountains, led to Ghizar and Andarp in the Kashkár territory.

53. Retracing my steps I returned to the hut and found that the owner had returned with a musk-deer. I told him I had gone higher up in search of him, and while waiting there had fallen asleep, and thus had not heard him calling for me as he said he had done when, on returning, he heard of me from his wife. Having bargained with him for the musk-pod, freshly cut off, I returned to my companions, who had met with no better success than myself as regards obtaining provisions. Having with considerable difficulty purchased a goat for Rs 13, we returned to the junction of the Záhar nadi, and sheltered in a deserted hut for the night. Here we found a large piece of a broken earthen vessel, and having lost our cooking utensils also under the avalanche in the Sumi valley, we were glad to use this to cook our food in. We had managed to procure, in addition to the goat, some vegetable, called *velne* in Pesháwar, which formed a welcome addition to our meal. This vegetable is also used for medicinal purposes, and is called by physicians *nána*. A small quantity of this, dried and pulverized, and taken with a little curd of cow's milk in the morning, is efficacious in curing dysentery. I was also informed that the waters of the Maidán river had the property of recruiting the strength of invalids very rapidly, and that the valley was on this account much resorted to by sick people from the neighbourhood.

54. I left the Záhar junction on the 20th July, and returning to the Maidán bridge, crossed the stream to its left bank, and traversed the road down on the bank opposite to that on which I had gone up. This portion of the road is very good, with gentle ascents

and descents, and is quite practicable for beasts of burden. The Sumi bridge had now been partially repaired, and I crossed over it to connect my work with my upward traverse. Recrossing again I proceeded down the left bank of the stream, passing on my left, about 200 yards from the bridge, a couple of huts, and near them some level ground which at certain seasons of the year, is cultivated. The road, with the exception of a few slight ascents, slopes gradually down all the way to Gabriál, following the joint stream formed by the Sumi and Maidán, which is called the Gabriál nadi. About five miles from the Sumi bridge another stream from the left joins the Gabriál, and about one and a half miles lower down the road crosses to the right bank. The valley now opens out again, the hills receding from the stream to a distance of about 300 paces, the intermediate plain being cultivated; and about two miles further on I reached the village of Gabriál.* This village contains about 40 houses, and is the residence of a celebrated, learned, and influential man, named Maulvi Habíbúlla.

55. I had brought a letter of introduction to the *malik* or headman of the Gabriál valley, but on my arrival here I heard he was dead. I then went to the Maulvi, who received me hospitably, and told me that he had heard of my coming and the loss of my property under the avalanche. He expressed his regret at my losses, and said that he would try and make up for them by obtaining timber for me at half the price usually paid; but he told me that my visit was at an unfortunate time, as, on account of the scarcity, good labour was not readily procurable, and what was done in ordinary seasons for two annas would now cost Rs. 2. He sent for the son of the late Khán, and, explaining to him my business, told him of the trouble in which I was involved. After consulting together they recommended my returning to Peshâwar for the present, and coming back to Gabriál next summer for timber. They gave me a long list of articles which they wanted from Peshâwar, and after entertaining me for a few days, allowed me to continue my journey. During my stay the Maulvi tried several medicines to check my dysentery, and pressed me to remain until it was cured; but finding myself no better, I begged his permission to proceed. I may here mention that the loss of my property proved rather an assistance to me than otherwise, in procuring me ready sympathy and help from the inhabitants of the Gabriál valley. Having gone there as a timber merchant, heavy demands would have been made upon me by various persons; but the story of my losses having preceded me, I was pitied by all and treated kindly everywhere.

56. The chief produce of the Gabriál valley consists of timber and ghee, both of which are largely exported to Peshâwar. Indian-corn is grown extensively, and I saw promising fields of it wherever I met with cultivated land throughout the valley. Wheat and barley are also cultivated to some extent, but rice is not grown. Figs, walnuts, and grape-vines were seen here and there, but not in abundance. During the present scarcity the chief food of the inhabitants consisted of a vegetable called *Khurpa*, which grew almost everywhere. I could not ascertain the cause of the scarcity, being told that last year's crops had been abundant, and with the exception of the destruction of some 40 houses by avalanches, which in about ten cases had not only destroyed the houses and the stores which they contained, but also killed the occupants and their cattle, no other cause of distress could be assigned.

57. I left Gabriál on the 26th July, and after proceeding down the valley about a mile and a half, I crossed a nadi from the right falling into the Kándia nadi about 300 paces to the left of the road. This stream comes from the Matiltán Pass; but as the range of mountains separating the Ushu and Gabriál valleys is known to the inhabitants of the latter by the name of Ushu, and as, moreover, the road to Ushu goes up this stream, it is called the Ushu nadi. From here the road skirts the base of the hills for 1¾ miles, the river being from 30 to 50 paces to the left. This is followed by a steep ascent of 560 paces, and then by a descent of 780 paces. About half a mile beyond this the road crosses the river by the Mírsháhai bridge, and keeps along the left for about half a mile further to the village of Mírsháhai, situated on the left bank of the Mírsháhai nadi, a tributary of Gabriál, about 300 yards from the junction. This village contains about 20 houses. About 2¼ miles further is the village of Serai, the *jágír* of Habíbúlla Khán Málik, situated on the right bank of a small stream issuing from the hills on the right, and containing about ten houses. Quarter of a mile beyond this village the road crosses to the right bank of the Gabriál by the Serai bridge, and following that bank for only 1,300 paces, it recrosses by another bridge to the left bank again. Two miles below this bridge is a third, by which the road again crosses to the right bank. Here I halted for the night.

58. On the 27th July, after proceeding about 2½ miles along the right bank, I again crossed the river by a bridge to the left bank, and about half a mile further reached the

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* The inhabitants of Gabriál, and of the Kándia valley generally, are of the Yashkani tribe of the so-called Dárdistán group. They are Shiahs, and, as the Mulla remarks in his narrative of the journey from Frub to Boinje, differ in appearance from the Afghans. The people from Kolai northwards dress in black, and many of them turn up the ends of their moustaches.

It might be as well to make here a note about Dárdistán, under which title Dr. Leitner embraces a great tract of country north-west of Cashmir. Now Dárdistán is simply another name for Chilás, also called Shanaik by the Gurais people. Dr. Leitner doubtless has good reasons for adopting this term out of many that might to others be equally convenient, but as Chilás is an almost insignificant place on the very outskirts of the region comprising the so-called Dard (pronounced Dárad by some) tribes, it does not seem apparent why the term has been selected. The so-called Dard group of languages I take to be as follows:—(1) The language of Kaffiristan, (2) Lughmani and Dari Nuri, (3) Damainch, (4) Chugani, (5) Bashkari, (6) Kashkári, (7) The Ghus languages, which include those of Kanza and Nagyr, Yasirs, Ponyal, Gilgit, Tangis, Darey and Gurnis, and (8) the language of the Yashkanis or Kolais.

village of Dong, on the left of the road, and about 60 paces from the river. The Gabriál valley, between the villages of Mírsháhai and Dong, is narrow, the hills being seldom more than 100 paces, and the stream about 50 paces from the road, which often crosses from one side of the stream to the other, and is impracticable for beasts of burden. The village of Dong contains about 30 houses. From Dong the valley is comparatively open, and the road is over tolerably level ground for a distance of 1,440 paces, whence it ascends gently to the village of Karang, about 1½ miles distant from Dong. Karang is situated close under the hills, and contains about 20 houses. Here I halted for the night.

59. Starting again on the 28th July, I proceeded in a southerly direction some 900 paces, slightly descending, to a wooden bridge over the main stream. Crossing this the road continues in the same direction for 860 paces, and then turns abruptly to the east, crossing the Bagru Dara, a swift mountain torrent 24 paces in width, by another wooden bridge. Up this Bagru Dara a well known road, practicable for laden cattle and much frequented by travellers and merchants, leads over the Surkár Pass to the village of Mánkiál in the Kohistán of Swát. The journey to Mánkiál takes from 2 to 2½ days. The Bagru Dara abounds with tall forest trees, and during summer is occupied by the inhabitants of Karang. From the bridge over the Bagru Dara the road follows the right bank of the main stream, and is easy for some 1,180 paces; then comes a steep ascent of 1,600 paces, followed by a descent of 1,600 paces, which, with the exception of one or two steep portions, is gentle. Two and a half miles further on the village of Kad is reached, on the left bank of the stream, containing about 15 houses. About three and a half miles below Kad is a bridge across the main stream for the convenience of the inhabitants of that vicinity, and three-quarters of a mile below this bridge and to the right of the road is the village of Dudshuín, situated on the left bank of a ravine, and consisting of about 20 houses. The valley here is about half a mile in width. About two and a quarter miles lower down, the Sayál Dara stream *debouches* from the hills to the right of the road, and joins the main stream. On the left bank of the Sayál Dara is a *kotha* and a small *masjid*, where I put up for the night. There was a little cultivation near here, and on the opposite bank of the Sayál stream was a water-mill. A path up the valley leads to Rázika.

60. Leaving this place on the 29th, I crossed the Sayál stream, and following the right bank of the main stream for about two and a half miles, reached the village of Helil, about 100 paces to the right of the road, on the right bank of a small stream, and containing about ten houses. A path up the valley from Helil leads to Rázika. Hearing that I was going to Seo, the inhabitants of Helil asked why I did not follow the shorter and easier route *viâ* Rázika, by which I could reach my destination in about two days; while the road I was following was circuitous and very difficult lower down, especially the portion along the Indus, and would take me four or five days. To satisfy them I asserted that I was going down to Kotgala to purchase *saglau* (beaver or otter?) skins which I had been informed were procurable there, and that I would then return and take the easier route which they had pointed out. Kotgala is about six miles from Helil, and is situated on the right bank of the main stream; it contains only four or five houses. The valley between the two villages is narrow and the road difficult.

61. I halted at Kotgala for the night, and made enquiries about the skins, but learned that the only one they had possessed of late had been sold to another passing traveller a few days before. In the course of conversation I complained to the headman of the village about the inconvenience of returning to Helil to continue my journey, and he was kind enough to give me a guide to direct and assist me by the nearer, though more difficult, route to Rázika and Seo.

62. I left Kotgala with the guide supplied me on the 30th July. For the first 400 paces the road is fairly level. The valley then closes in and the stream forces its way through a gorge with perpendicular hills on both sides, the road ascending steeply for 1,200 paces and then descending abruptly for 1,700 paces, to where the Gabriál stream, here known as the Kándia nadi, falls into the Indus, the junction being about 50 paces to the left of the road. The path now winds along the face of the hills on the right bank of the Indus for about a mile and three-quarters, and is extremely difficult even for foot passengers: on this account it is very seldom used. The Gayál Dara stream here joins the Indus. Crossing this stream at 400 paces from it I found a small *kotha* (then uninhabited) with a water-mill and some cultivated ground near it. My guide now told me that Seo was distant about six or seven miles by the path along the bank of the river; but as at this season of the year portions of it were under water, he considered the route quite impracticable. We therefore went up the right bank of the Gayál stream over a difficult ascent for a mile, and then proceeded along the face of the hills for about 760 paces over a pretty level road with some 20 scattered houses on both sides of the stream. These habitations are the summer homes of the inhabitants of Seo. Indian-corn is largely cultivated, and figs and vines abound. The road now crosses to the left bank of the stream, and for a mile and a quarter further the valley is very narrow, the road crossing from one bank to the other several times, and rising gently the whole way, till it reaches a grove of tall trees, whence a steep ascent of about 800 paces leads to the village of Gayál. This village consists of about 40 houses scattered along the right of the road for about a mile, and is also a summer retreat for the people of Seo. The slopes of the hills above Gayál are gentle and well cultivated with Indian-corn; vines grow abundantly and line the road for the whole distance through the village. I halted at Gayál for the night.

63. Starting from Gayál on the 31st July we crossed over to the right bank of the stream, and passed over gently rising ground for two and a half miles, the valley throughout this

distance being open, and from 200 to 250 paces broad. After this, there is a difficult ascent of about a mile up a ravine to the left, to the top of the Air Bek Kandan or Pass. The soil about here is clay mingled with stones, and the hill-sides were covered with forest. From the pass a difficult and steep path goes down for about one and three-quarter miles to Dáud Bánda, which contains about ten houses inhabited by *Gujars*. To the left of the road at this place, is the head of the Doga Dara, which drains into the Indus.

64. Halting here for the night, I left again on the 1st August, and after proceeding about three and one-fourth miles arrived at Súr Bánda, also inhabited by *Gujars*, crossing on the way three streams, the first two of which were frozen over, and the third, which drains from the Yáva Kandan and flows close past Súr Bánda, is spanned by a wooden bridge. This stream falls into a lake to the right of the road about 800 paces long, and issuing thence and being joined by the former two, falls into the Doga Dara. From Súr Bánda an easy ascent of 3,400 paces goes up to the top of the Yáva Kandan; the valley along this distance is about 200 paces wide, and was covered with snow. From the pass the descent on the other side is very steep for about 1,300 paces; a stream rises from near the top to the right of the road, and flows along on that side for some distance to the bottom of the steep descent, where it crosses the path and flows towards Rázika. From here the road again ascends gently for 300 paces, and then descends steeply for 1,260 paces to another small stream flowing towards Rázika. For a distance of about three and a quarter miles the ascent is gentle and the road crosses four streams, all flowing from the snow-covered hills to the right; the fourth and longest of which drains from the Zelai Kandan. I estimated the sources of the smaller streams to be about a mile from the road, and about a mile below it they join the Rázika nadi, which flows into this Indus near Seo. About 900 paces of easy ascent from the Zelai stream takes one to Gedar Bánda, a village of about 40 houses scattered about the neighbourhood, and one of the summer retreats of the people of Seo. Indian-corn is here largely cultivated.

65. At Gedar Bánda I found an acquaintance. The fever and dysentery which I had been suffering from in the upper part of the Gabriál valley I had not yet succeeded in shaking off, and finding me very weak, my friend insisted on my staying with him for some days to recover my strength; he also gave me some medicines which did me good.

66. As I wanted to connect with my former work at Seo, I had given out that I was anxious to visit my friend there, but now having found him at Gedar Bánda I had to devise some other pretext for going to Seo. I told my friend that during my visit to him in my last journey, having had occasion to bathe at his house, I had taken off from my arm a *tawiz* (a charm encased in copper, silver, or gold, and worn round the neck or arm) and having hidden it under some stones for safety sake, had forgotten it there. Not discovering my loss till I was several days' journey from Seo I did not care to return, but gave up the idea of recovering it till some future opportunity. My friend offered to send a man to look for it; but as I told him if the man failed to find it I should not be satisfied without a personal search; he permitted me to visit Seo.

67. After a stay of two days at Gedar Bánda, I and my companion started for Seo on the 4th August, leaving the rest of my servants with the baggage at Gedar. The road descends for nearly a mile and then crosses the Zelai stream by a wooden bridge. For 2,840 paces further the road is pretty level, with hills on the left, distant from 1,000 to 1,500 paces, and the Zelai stream on the right, from 100 to 400 paces distant. The village of Rázika, situated along this portion of the road, consists of about 300 houses. There are several water-mills along the stream, and the ground was well cultivated. Figs, walnuts, and vines abound in this neighbourhood. Crossing the Rázika stream by a wooden bridge just above its junction with the Zelai, I descended about 760 paces, and again crossed to the right bank of the joint streams by another wooden bridge. The road now follows the right bank the whole way to Seo. For about a mile the valley is very narrow, a mere gorge through which the stream, some 20 paces wide, forces its way; it then opens out again, and four and a quarter miles further brought me to Seo, where I put up for the night. I noticed dense forest on both sides of the road on this day's march.

68. I left to return to Gedar Bánda on the 5th, and on the road near Rázika I found my friend with a number of men awaiting my return. I had been delayed on account of my weakness, and he, anxious at my non-arrival, had come out to see if he could render me assistance in any way. We arrived at Gedar late in the evening, and during the night I asked my friend's permission to resume my journey homewards. He supplied me with some provisions which I had asked him to collect and purchase for me while I was at Seo, and also desired one of his brothers to accompany me as far as Kána. On account of the prevalent scarcity it was necessary always to carry some days' provisions, as it was not easy to obtain them everywhere.

69. I left Gedar on the 6th August, and after a generally gentle ascent of nearly three miles reached the Zelai Kandan; the road leading up the Zelai Dara and the hills on both sides being covered with forest to near their summits, which were under snow. Having started from Gedar rather late, I remained near the pass for the night, and next morning descending from it for half a mile, came to another ascent of 800 paces, succeeded by another descent of 1,400 paces. I here crossed over snow the head of the main stream of this valley, and after an ascent of a little over two and a half miles reached the top of the Shamalda Kandan. The whole of this portion of the road was under snow. From the top of the Shamalda Pass the road descends gently for 4,850 paces into the first Patan Dara, not the stream which

drains past Patan, but so called from being subject to the people of the Patan valley. For the next 1,300 paces the road ascends, and then there is about a mile of uneven ground, ascents and descents, when the road crosses another stream and rises some 1,400 paces to the Enalkand Kandan. This portion of the Patan Dara at certain seasons of the year is occupied by *Gujars* who bring their cattle for pasturage. From the top of the Enalkand Pass to the second Patan Dara is a descent of over five miles, steep in some parts and gentle in others. This valley is also called Patan merely from its being subject to Patan. There are a few scattered habitations and cultivated fields here and there along this descent. I put up in a small water-mill *kotha* for the night, near the stream which flows through this valley. The valley. I was informed, was well inhabited lower down.

70. Starting again on the 6th August I crossed the stream by a wooden bridge and took my way up a tributary, the Káhal Dara, by a steep ascent of a mile and a quarter till the stream was crossed, and then the road continued along the left bank with a more gentle ascent for half a mile. The road then leaves the stream, and after an ascent of 1,200 paces reaches the Káhal Kandan, on the top of which is a *siárat* on the roadside. From here a steep descent of 1,800 paces leads to the Sagán Dara stream, which is crossed by a wooden bridge. The road goes down the right bank about 1,200 paces, and then up the left bank of a tributary stream, which it crosses about 500 paces higher up. There are some 20 houses belonging to Patan, scattered about in this vicinity. The road still ascends for another 1,300 paces to the top of the Hazdar Kandan, whence there is a descent of nearly two miles into the real Patan Dara, to the stream which flows past the town of Patan on the Indus; a road down this valley on the left bank of the stream leads to Patan. From the stream an ascent of half a mile, followed by about two miles of fairly level road along the hill-side, leads to another stream which crosses the road and joins the main stream about two and a half or three miles to the left of the road. There are a few habitations and cultivated fields in this valley. For two miles further the road continues along the hill-side with gentle rises and falls, and then goes up by a difficult ascent of a mile to the Duber Kandan. Hence a very difficult descent of 3,300 paces along a spur leads to a small stream, and after another stiff descent of a mile and a half, the bed of a dry torrent is reached. After another three quarters of a mile of gentle descent the road crosses, by a wooden bridge, the main stream of the Duber Dara. There are about 20 houses on the left bank of this stream, and the valley above and below this spot is somewhat open for about a distance of three miles.

71. I stayed here for the night, and starting again on the 9th August, after a gentle ascent of half a mile followed by 700 paces of pretty level road, I reached Duber village, which consists of about 60 houses. Proceeding 1,300 paces further, I crossed a stream flowing from the right and falling into the Duber stream, about 600 paces to the left of the road. This valley abounds in good timber which is cut and floated down to the Indus for the Peshawar market. From the stream is a steep ascent of 1,200 paces, and then for about two and three-quarter miles the road passes over gentle elevations and depressions with level portions here and there; at the end of this distance it crosses another stream, and then, after an ascent of two and a quarter miles reaches the top of Ranulia Kandan, two and three-quarter miles beyond which is another slightly higher pass, the Kup Kandan. Descending thence about a mile and a quarter, the road crosses the Kup Dara stream, then frozen over. The valley is open, and I saw in it some *Gujars* with their cattle, but no habitations. From the stream there is a gentle ascent of 3,340 paces to the top of the Kúpu Kandan, from which the road again descends gently for over a mile, and then ascends for 400 paces to Kúpu Banda, crossing three streams flowing under the snow, which take their rise not far off in the snow-crowned range of mountains to the right of the road. Kúpu Banda consists of about 25 houses occupied by *Gujars*. Here I put up for the night.

72. Leaving here on the 10th August we ascended for about 800 paces, then passed over three quarters of a mile of level ground, and after another quarter of a mile of ascent reached the Kána Kandan. From here there is a very difficult descent of a mile, followed by an easier one of over two miles; this portion of the road following the stream and often crossing from one bank to the other. The Kána Dara for about a mile further is open, about a mile in width, and the road nearly level, keeping to the right bank of the stream. Then follows a descent of 600 paces, after which the road crosses to the left bank by a wooden bridge, and about 40 paces below the bridge the stream joins the Brij nadi, so called from a village of that name about a mile and a half higher up. The Kána Dara from the bridge above-mentioned down to Karore village is open; the road along it slopes gently and is practicable for beasts of burden. Indian-corn, wheat, barley, and paddy are largely cultivated in this valley. For about half a mile from the bridge the road keeps to the left bank of the nadi and arrives opposite to Ganshiál village, containing about 400 houses, and situated on the right bank of the stream. About a mile and a quarter further, a road to Ghurband branches off to the right up the Khurlanai Dara, which valley has a few houses in it. Proceeding another 700 paces along the same bank of the stream I arrived at Bilkána village, situated close to the left of the road, and containing about 400 houses, mostly inhabited by *paráchas* with a few families of Hindu *banias*. Here I halted for the night.

73. The inhabitants of the Kána valley possess large herds of cattle and flocks of sheep and goats, and export large quantities of ghee and blankets. Two and a half miles from Bilkána, which I left on the 11th August, the road crosses to the right bank of the stream by a wooden bridge known as the Dámorai bridge, from the village of that name,

containing about 200 houses and situated about 300 paces to the left of the road. At a distance of nearly three miles below this bridge is the village of Barkána, containing about 300 houses, and also situated close to the left of the road. About a mile beyond Barkána the road passes through the village of Dalai, containing about 500 houses; two and a half miles further down the valley is Zorkhána, and another two and a half miles beyond it I arrived at Serai.

74. The village of Serai Saiyidán (of *Saiyids*) is situated on the left bank of the Ghurband stream, and comprises about 30 houses on both sides of the road. It was late in the afternoon when I arrived here; but the weather being cloudy and there being no bridge over the Ghurband nadi, I decided not to remain here for the night, but fording the river, proceeded to the village of Karore, about 600 paces from the opposite bank, and containing about 60 houses.

75. I left Karore on the 12th August and followed down the right bank of the Kána Dara for about 1,200 paces, passing in two places groups of detached houses belonging to Karore. The valley lower down towards its junction with the Indus being narrow and uninhabited, the road leaves it and ascends the hills on the right. The inhabitants of Kána Dara, and of all the lateral valleys draining into the Indus below it, are Afgháns, resembling in appearance, manners, &c., the generality of Pathans. Their arms are muskets of various kinds (*toredár*, flint, and percussion), swords, spears, and shields. The mountainous country between the Swát valley up to Kalám and Ushu on the one side, and the river Indus down to Kána Dara on the other, with the exception of the Kándia Dara, has no permanent habitations in it. The inhabitants of the villages along the Indus drive their flocks and cattle up the lateral valleys during summer, and take up a temporary residence; but they do not ascend to the central chain of mountains bordering the Swát valley on the east. The Kána Dara, however, and the valleys below it are permanently inhabited. The people of the Kándia Dara are Kohistánis, and resemble the men of the Indus Kohistán; but on account of the famine which was then raging they looked very lean and dark-coloured. Their arms consist of muskets, swords, spears, hatchets, and shields, also a few muzzle-loading rifles with percussion caps. They manufacture their own powder. They are both an agricultural and pastoral people, cultivating considerable tracts of country and having also large flocks and herds. Musk-deer are found in the higher portion of the valley; and the musk-pods are brought down to Kána and bartered generally for lead and salt.

76. Ascending out of the Kána valley, up the hills to the right for some 800 paces, and proceeding about half a mile further, along an almost level road, I arrived opposite Nográm, a village in the Upal Dara, containing about 20 houses, and situated 100 yards to the right of the road. From here the road goes up the Upal Dara over gradually rising ground for about six miles to the top of the Upal or Chakesar Kandan, passing the villages of Puniál and Upal about half a mile from Nográm. There are about 400 houses in this valley, including these three villages. Figs abound here, and at this time were the chief food of the inhabitants. From the top of the pass the road descends into the Chakesar valley, and follows the course of the stream for about six miles to Chakesar, a village situated in an open plain about a mile wide, containing about 1,000 houses, and having numerous shops for the sale of provisions, &c. The Chakesar Dara from about three miles above the village is well cultivated. Here I remained three days to prepare for my further journey.

77. I left Chakesar on the 16th August, and after proceeding about a mile and a half crossed over to the right bank of the Chakesar stream; the valley here being narrow. Some 700 paces further, the road again crosses the stream and continues along the left bank for about two and a half miles, when it again crosses to the right bank and follows that bank for two miles to the junction of the Chakesar with the Indus. The road down the stream is very uneven and difficult for beasts of burden: there are no bridges and the river has to be forded. From the junction I followed the right bank of the Indus to Kábalgrám and remained there for the night.

78. As the route along the Indus had been previously explored, I hit upon a pretext for deviating from it and proceeding by the Itai nadi as I had been instructed to do. Most of my servants were men from Swát, which valley is only about two days' journey from Kábalgrám, and I asked them whether they would prefer to return home direct, or after accompanying me by the Indus route to Peshawar. I informed them that I was short of funds, and that my only object in taking them so far round with me was to be able to pay them up before parting; but that if they did not insist upon immediate payment, I was willing myself to go *viâ* Swát and leave them at their homes, the more so as I could thus have an opportunity for a pilgrimage to the *siárat* of the Akhúnd Sáhib. To this they readily consented; but as the Itai nadi was flooded that day, I had to halt for a day at Kábalgrám.

79. I started on the 18th August, and proceeding along the Indus to the *siárat* of Akhún Bába, I entered the Itai Dara. The road up this valley ascends gradually to the top of the Puran Kandan, distant about 12 miles from the *siárat* of Akhún Bába, and there are no bridges along it; so that the stream has to be forded in two places where the road crosses from one bank to the other. Along it are the villages of Gir, Bishkand, Katoz, and Serai, where I remained for the night of the 18th August. There are altogether about 500 houses in this valley, including the four villages above-named. Up to Serai it is a narrow valley only partially cultivated. The road is not practicable for beasts of burden. The hills on the left belong to Chakesar, those on the right to Chárgazai. Above Serai the valley is more open, about a mile in width, and belongs to Mákhozai. Descending from the Puran

Pass along a gentle fall for about quarter of a mile, I arrived at some springs of fresh water to the right of the road with a number of fig trees about them. A little over two miles beyond these springs the road passes the village of Barbaikot, containing about 20 houses, in the Puran valley. A mile and a half further along the road is the village of Aloch, containing about 500 houses, several of which are inhabited by *paráchas* and Hindu *banias*. A little more than a mile further is the village of Bin Galai, where I put up for the night of the 19th August. This village contains about 250 houses. The Puran valley is well cultivated, and rice of a good quality is grown here.

80. Leaving my Swát servants to collect provisions at Bin Galai, I and my companion started on the 20th of August for Chakesar, to connect with my traverse down to that point. We crossed the intervening ridge by the Puran Kandan, and reaching the village, remained there for the night, starting on our return to Bin Galai very early the next morning, as I had told my Swát men that I was only going to a hamlet on the ridge for ghee, and that if not back by evening, I would be with them early the next day. On the road to Chakesar we passed Huárai Bánda on the Bin Galai side of the ridge, and across it the Káglun springs, and the village of Shawáhai containing about 40 houses, and situated about two and a half miles from Chakesar. The road is not difficult for foot passengers or unladen cattle, but rather so for beasts of burden.

81. Arrived at Bin Galai again, we at once proceeded on our journey, along the left bank of the river, and at about one and a half miles reached Sandin, a village of about 150 houses. Half a mile further we arrived opposite to Chágam on the right bank of the stream, containing about 200 houses; half a mile beyond this again we came to Sanela village, also comprising about 200 houses. Proceeding some two and a half miles further along a fairly level road we crossed two streams close together, and ascending thence about a mile passed some tombs near the road and a few huts off to the right of it. For half a mile further the road lies along the side of the hills, nearly level, and then ascends 660 paces to Barabandai Bánda, a hamlet of about 30 scattered houses. The ground about here is well cultivated, chiefly growing Indian-corn; fig trees also abound. Here we remained for the night.

82. On the 22nd, after a gentle ascent of about a couple of miles, and a steep climb of another half mile, we crossed the Ghurband Kandan. From the top of this pass the road descends gently by the Yakhtánge ravine for about three miles to the village of Bázárge, situated on both sides of the stream, and containing about 90 houses. The ravine is very narrow, and the road from the pass often crosses from one side to the other.

83. It was afternoon when I arrived at Bázárge, and as I wanted to explore the upper portion of the Ghurband valley, I feigned fatigue, and told my men to cook their food at this village; whilst in the meantime I would bathe in the stream, and, if possible, refresh myself with a little rest in some convenient spot. About 480 paces below the village I reached the junction of the Yakhtánge ravine with the main Ghurband valley, and turned up into the latter. Near the junction is a bridge over the main stream, across which a road goes to Swát. About a mile up the Ghurband valley is Hamnui village, on the left bank of the stream, about 1,000 paces above its bed, and containing about 50 houses. About two and a half miles further I came to a steep ascent, up which a little-frequented path was seen going, perhaps to some hamlet higher up. Returning to Bázárge, I put up there for the night.

84. Starting again on the 23rd August, we crossed the Yakhtánge stream by a wooden bridge, and proceeding along the right bank of the Ghurband nadi over a pretty level road, came to Jatsar village, about two miles distant from Bázárge, containing some 60 houses. About 400 paces lower down we crossed to the left bank, and ascending for half a mile, reached the village of Barkotke, containing about 300 houses. Here supplies of all kinds are procurable, as the village is considerably resorted to by Swát traders. Here I halted for the night. The Ghurband valley is narrow, but the road is practicable for beasts of burden.

85. My companion's foot had swollen in the journey from Bin Galai to Chakesar and was becoming worse daily, so that he was scarcely able to walk. I therefore persuaded my Swát servants to remain for a few days at Barkotke to allow his foot to heal, telling them that I was very much knocked up by the journey, and would amuse myself for a few days wandering about the vicinity and talking with the learned men. I started off alone early the next day for Serai village in the Kána valley. Following the left bank of the Ghurband nadi, the bed of which is about 300 or 400 feet below the road, I arrived at Kuzkotke, containing about 250 houses, about a mile and a quarter from Barkotke. Proceeding thence for two and a half miles along a very uneven road, I crossed to the right bank of the stream, and half a mile further on arrived opposite to the junction of the Lilonai Dara, up which a road, crossing the range, descends by the Khurlanai valley to Bilkána in the Kána valley. About 800 paces further I crossed to the left bank of the Ghurband by a wooden bridge, and following that bank for over half a mile of uneven road, arrived at Alpura, a village of about 300 houses. At a distance of 1,200 paces below Alpura I forded the stream to its right bank, and proceeding along it over a generally uneven and difficult road for ten and a half miles, I reached Serai. In this distance occur the villages of Derai and Jakat, both situated to the right of the road, and consisting of about 50 and 40 houses respectively.

86. The Ghurband valley throughout its length is narrow, and on account of the steep hills on each side has not much ground fit for cultivation. Indian-corn, barley, and wheat are sown where favourable localities occur; rice is very little cultivated. The valley however, is populous, and can, I was informed, muster 6,000 to 7,000 fighting men; the inhabitants are generally poor.

87. Although I had intended going only as far as Serai, an incident occurred shortly before I reached that village which obliged me to go down a little further. I met one of the *Saiyids* whom I had become acquainted with at Serai on my downward journey through the Kána valley, and he was astonished to see me coming down the Gurband valley. I pretended that I had left a valuable book of prayers in the *masjid* at Karore, where I put up the night I left Serai, and having changed my mind with regard to taking the Indus route to Pesháwar, and adopted the Swát route instead, in order to make a pilgrimage to the *ziárat* of the Akhúnd Sáhib, I had availed myself of the proximity of their valley to this route to come across for a day to try and recover the missing book. Having thus satisfied him, I proceeded to Karore, and made diligent search for my imaginary lost property. Asking the headman of the village to send the book to me at Pesháwar if it were found, I started on my return journey to Barkotke next morning. I may note that being alone on this journey, I was twice approached by passing villagers while using my instrument and recording my observations, without my noticing them coming; but as I pretended to be absorbed in my work and did not seem to seek secrecy about it, I was not even questioned as to what I was doing.

88. Leaving Barkotke again on the 26th August, I reached the top of the Kotke Kandan by an easy ascent of about two and a quarter miles, the road being quite practicable for beasts of burden. From the top of the pass is an ordinary descent of one and a half miles, followed by about half a mile of gently sloping road along a stream to the village of Mangarkot, containing about 20 houses. From Mangarkot a steep descent of about 1,400 paces leads down to the bed of the river, proceeding along which for a mile I reached Shaftálu Bánda, situated some 200 paces to the left of the road, and containing about 20 houses. About 800 paces below Shaftálu, a road much frequented by traders diverges to the right, and ascending a low pass, descends a valley to Chahár Bágh. For about a mile from where this road diverges; the road I followed passes along the base of the hills on the left, and is very uneven. It then descends again to the bed of the river, and after following it for about two and a half miles, crosses over to the right bank. Proceeding for about 300 paces, it again crosses to the left bank opposite to Ser village. This village is situated about 600 paces from the river, in an open and cultivated part of the valley, and consists of about 40 houses. After crossing a tributary stream a third of a mile beyond Ser, and following the left bank for 400 yards further, the road crosses to the right bank of the main stream, the Manglor river; and one and a half miles beyond this is the village of Tálagrám. Half a mile beyond Tálagrám the road recrosses to the left bank of the river, and three miles below the crossing we reached the Jámbil-Kúkárai stream, so called from two villages situated on it higher up. The valley here is open, the road level, and practicable for its whole length for beasts of burden. Proceeding about 800 paces from the Jámbil-Kúkárai we reached the village of Manglor, consisting of about 700 houses. Supplies of all kinds are here procurable. Here I halted for the night.

89. Leaving Manglor on the 27th August, about half a mile from it, we crossed the river to the right bank, and proceeding away from the stream about two and a quarter miles we arrived at Chahár Bágh. This portion of the road for about a mile skirts the hills on the right, with an open cultivated plain to its left; it then strikes through the plain, with fields on both sides. Chahár Bágh contains about 1,000 houses. About a mile from it is the ferry across the Swát river; crossing here, and proceeding about 800 paces, we reached Dile Bánda, a village containing about 20 houses, and situated on a small island formed by the bifurcation of the Swát river. About 500 paces from Dile Bánda we crossed the other branch of the river, and a little less than a mile further reached Barabandai, through which I had passed on my upward journey. Here I closed work.

90. For the greater portion of the journey from Abazai to Kalám, and from Kábalgrám through the Itai, Puran, Ghurband, and Manglor valleys, and also in the Chakesar valley, the road was infested by robbers. Formerly travelling was quite safe; and I attribute the increase of crime partly to the death of the Akhúnd Sáhib, who kept the country in order, and partly to the famine.

91. I left Barabandai on the 28th August and arrived at Ghálige. From Ghálige I proceeded on the 29th to Thána, and crossing the Mura Pass, halted for the night at Kharke in British territory. My Swát servants, inhabitants of Barabandai, who accompanied me so far to see me safe out of their country, now returned home; and on the 30th August leaving Kharke, I reached my own home in the Pesháwar district.

Alphabetical List of Local Names in Mullah's Narrative for 1878.

A.

Aba Sind.
Attock.
Abazai.
Aládand.
Azgar.
Asíl.
Agra.
Andarp.
Air Bek.
Aloch.
Alpura.

B.

Badwán.
Barshin.
Bara Totai.
Barangola.
Barániál.
Batkhela.
Bahandra.
Bajáur.
Bagru.
Brij.
Bilkána.
Barkána.
Bishkand.
Barbaikot.
Bin Galai.
Barabandai.
Bázárge.
Barkotke.

C.

Chakdara.
Churrai.
Cham.
Chakesar.
Chárgazai.
Chágam.
Chahár Bágh.
Chahár Sadda.

D.

Dir.
Durushkhela.
Darál.
Ding.
Dong.
Dudshuín.
Dáud.
Doga.
Duber.
Dámorai.
Dalai.
Derai.
Dile.
Darwázgai.

E.

Enalkand.

G.

Gandere.
Gilgit.
Garidagi.
Gabriál.
Ghizar.
Gayál.
Gedar.
Ghurband.
Ganshiál.
Gir.
Ghálige.

H.

Hazára.
Hag.
Helil.
Hazdar.
Huárai.
Hamnui.
Hashtnagar.

I.

Issar.
Ingzre.
Itai.

J.

Jinde.
Jálkot.
Jakát.
Jámbil.
Jatsar.

K.

Kándia.
Kabul.
Kot.
Kur Badwán.
Kashkár.
Khár Batkhela.
Kararai.
Kohistán.
Kám Agra.
Kalám.
Kolai.
Kána.
Karang.
Kad.
Kotgala.
Káhal.
Kup.
Kúpu.
Karore.
Khurlanai.
Kábalgrám.
Katoz.
Kúkárai.
Káglun.
Kotke.
Kharke.

L.

Lámuti.
Lundi.
Lálpura.
Láspur.
Lilonai.

M.

Michni.
Matkanai.
Mingraura.
Malezai.
Matiltán or Matákán.
Máhr.
Mírsháhai.
Mánkiál.
Makhozai.
Mangarkot.
Manglor.
Mura.
Maidán.

N.

Nikpikhel.
Náranj.
Nográm.

P.

Panjkora.
Pesháwar.
Parrai.
Pálas.
Patan.
Patrák.
Paloga.
Palesar.
Puniál.
Puran.

R.

Ramora.
Rámpur.
Rázika.
Ranulia.

S.

Swát.
Shamilai.
Sarsenai.
Shangwatai.
Sibujni.
Sajáun.
Seo.
Sumi.
Surkár.
Serai.
Sayál.
Súr.
Shamalda.
Sagán.
Shawáhai.
Sandiu.
Sanela.
Shaftálu.
Ser.

T.

Totai.
Totekán.
Thána.
Tighak.
Tutke.
Tal.
Tangir.
Tálagrám.

U.

Uch.
Uchnu.
Utrot.
Ushu.
Upal.

Y.

Yusafzai.
Yáva.
Yakhtánge.

Z.

Zahar.
Zelai.
Zorkhána.

Glossary of Vernacular words and terms used.

Bánda	...	Hamlet or cattle sheds.
Bara or Bar	...	Upper.
Bania	...	A grain and provision merchant (Hindu).
Dara	...	Valley.
Fakír	...	A religious mendicant.
Gunda	...	Kind of coin.
Gujar	...	Pastoral nomad.
Imám	...	Priest.
Jabba	...	Lake.
Jála	...	Raft or inflated skins.
Jágir	...	Grant of land, freehold.
Kandan	...	Pass.
Kacha kotha	...	Mud hut.
Khán	...	A chief.
Kuza or Kuz	...	Lower.
Lambardár	...	Head man of a village.
Malatár	...	Soldier.
Masjid	...	A Mahomedan place of worship.
Malik	...	Head man of a tribe.
Mallah	...	Mahomedan lawyer, doctor, or other learned man.
Muhammad Sháhi		Kind of coin.
Nadi	...	River.
Nawe	...	New.
Pathán	...	A sect or tribe.
Pashtu	...	The language of.
Parácha	...	A grain and provision merchant (Mahomedan).
Piwich	...	A species of pine tree.
Ranzro	...	A species of pine tree.
Saiyid	...	A sect of Mahomedans claiming direct descent from the prophet.
Sind	...	River.
Saglau	...	Beaver or otter.
Táwíz	...	A charm.
Toredár	...	A kind of gun fired by a lighted fuse.
Ushur	...	A tithe or tax.
Ushurián	...	Collectors of the *ushur*.
Ucher	...	Species of pine tree.
Ziárat	...	A tomb or shrine.

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Extract from the Proceedings of the Government of India in the Home, Revenue and Agricultural Department (Surveys),—under date Simla, the 17th May 1880.

READ—

General Report on the Operations of the Survey of India during the year 1878-79, submitted with the Surveyor General's letter No. 888, dated the 25th March 1880.

RESOLUTION.

THE present Report is the second received since the Great Trigonometrical, the Topographical, and the Revenue Branches of the Survey Department were amalgamated into the Survey of India. It is satisfactory to find that the amalgamation is so far a success, and that the consolidated department is working, on the whole, smoothly.

2. The principal triangulation of all India has now been nearly completed. Accordingly, only one party, that engaged in framing the Madras Coast series of triangles, was employed on this work. A good outturn was accomplished in the alluvial flats of the Coleroon, Veller, and South Pennar Rivers, and in the intervening plateaux. The result is opportune, as a Revenue Survey party has recently broken ground in the South Arcot District, and its operations can be based on the points now fixed. Secondary triangulation proceeded, under three parties, in Burma, Siam, Upper Sind, and Beluchistan. In Burma some progress was made on the banks of the Bassein River and along the coast in the Rangoon or Hanthawaddy District towards the Krishna Shoal. Great difficulties were experienced owing to the dense growth of jungle and the scarcity of labour. The Eastern Frontier chain of triangulation had reached a line about 35 miles South of the parallel of Tavoy opposite a point on the British and Siamese frontier, whence the direct distance to Bangkok, the capital of Siam, is less than 90 miles. The great object of the operations of the season was to directly connect Bangkok with India by a chain of triangles across the Siamese Peninsula. At the outset, in British territory, the party were confronted by a maze of intricate hills, almost uninhabited and covered with dense forest and tropical vegetation; rains of unusual duration and sickness also impeded their exertions. The triangulation in Siam was, however, completed up to a point within 25 miles of Bangkok. The Governor General in Council has learnt with much satisfaction that the Siamese officials facilitated the work to which the Government of Siam had, on the proposal being made to them by Mr. Knox, the Consul General in Siam, given their cordial assent. Owing to the exigencies of the Afghan campaign, the Upper Sind and Beluchistan party was left in charge of an Assistant. Triangulation was extended beyond Quetta to the boundary of Pishin, and a connection was made with the stations of a preliminary triangulation, emanating from a provisional base line measured at Quetta, which has reached to Kandahar.

3. Eleven parties were employed on topographical work in Malwa, in different parts of Rajputana, in the Meerut Division of the North-Western Provinces, in Kattywar, Guzerat, Khandesh, and

the North and South Deccan, in Mysore, and in the Sylhet District of Assam. The general outturn of topography was as follows:

5,424	square miles	surveyed	on the ½-inch	scale.
8,778	„	„	1-inch	„
9,179	„	„	2-inch	„
218	„	„	4-inch	„

Seven towns and cities, of an aggregate area of 51 square miles, were also surveyed in detail on various scales,—6, 12, 16 and 80 inches to the mile—*pari passu* with the topography.

The Malwa survey embraced portions of the Native States of Gwalior, Indore, Jhabua, Dhar, Sailana, and Rutlam. The party usually engaged on the Gwalior and Central India survey was partly diverted from its ordinary work to take up special surveys in the Native State of Jodhpore, required by the Inland Customs Department in consequence of the revised arrangements for the taxation of salt. The Pachbadra salt pits were mapped on a large scale, and the course of the Luni River from the pits to the Runn of Cutch was delineated. The Rajputana survey party triangulated an area of 9,860 square miles in Bickaneer Territory, and executed in the States of Jodhpore, Bickaneer, and Shaikhawáti the detail survey on the ½-inch scale of 5,424 square miles already mentioned. In the Meerut Division of the North-Western Provinces the survey of the Saháranpur District was completed; an area of 482 square miles was mapped in the Muzaffarnagar District on the 2-inch scale, and 4-inch village maps of the alluvial tract along the Jumna, including the bank in the Umballa District of the Punjab, were prepared. The Financial Commissioner of the Punjab has been addressed by the Surveyor General with regard to the extension of this special survey to the Jumna alluvial lands of the Delhi and Karnál Districts. As the Jumna is here the boundary between the two Provinces, and good maps immensely facilitate both the revenue management of riverside lands and the decision of suits regarding alluvion and diluvion, the Government of India quite concur in the remark of the Surveyor General that the subject is well worth the attention of both the Local Governments concerned whilst the survey party is in the vicinity.

4. Out of the eleven topographical parties, five were at work in Western India. The operations of the Kattywar party lay principally in the Hálár and South Prants of that province, and included an area of about 500 square miles in the difficult hill tract of the Gír, a well-known refuge for marauders. The malarious character of this part of the country precluded its survey till the season was far advanced. Only 480 square miles now remain for topographical survey in Kattywar, and an area of 884 square miles was triangulated in advance in the sister province of Cutch, where a beginning has been made, now that the Kattywar survey is nearly finished. The ordinary topographical work of the Guzerat party was carried over an area of 1,203 square miles in the Ahmedabad and Kaira Collectorates, in Baroda Territory, and in the Mahi Kántha and Rewa Kántha States. A special forest survey on the 4-inch scale was also in progress in the Dangs, a tract on the edge of the Northern Deccan. The portion already surveyed is a mass of bold and complicated hills overgrown with thick forest. The Khandesh and Bombay Native States survey party spread their triangles over the South-East corner of the Khandesh District, effected a detailed 1-inch survey of 642 square miles, mainly between the Satpura Hills and the Nerbudda and Tapti Rivers, and a similar survey, but on the 2-inch scale, of 893 square miles chiefly in the tract between the Tapti and the town of Dhulia. The area allotted to the North Deccan party having been

nearly completed, it was decided that their operations should extend to the Konkan, the country lying between the Western Ghâts and the sea: 1,400 square miles of this part of the Presidency were accordingly triangulated; but the topographical work of the year lay in the South-West of the Ahmednagar Collectorate and the adjoining talukas (sub-divisions) of the Poona District. The field of the employment of the South Deccan party was chiefly the Sholapur Collectorate: the outturn was 1,402 square miles on the 2-inch scale, and 576 square miles on the 4-inch scale; the latter survey being required by the Bombay Public Works Department in connection with one of their large irrigation projects.

5. The survey of the Mysore State on the 1-inch scale was continued, the party working in two detachments. Of these, one was employed on triangulation in the Malnád, the highland region bordering on South Canara; the second on ordinary detail and on large scale forest survey principally in the Túmkúr and Kolar Districts, but also to some extent in Chitaldroog and Bangalore. In the Sylhet District of Assam, owing to the constitution of the survey party and the dense vegetation of the conntry, little was done; but it is said that by the operations of the year the maps of hitherto unsurveyed tracts at the foot of the Khási and Jaintia Hills can be completed, and sundry small blanks in others filled up. The future programme has here at length been settled after considerable discussion; and it is hoped that during the field season now about to close better results will have been attained.

6. The Punjab was the only Province in which any mouzawar or village surveys were in course of execution during the year. The 4-inch survey of the Dera Ismail Khan and Bannu Districts was continued, the work in the latter district coming to a close. Some progress was made in the Murree and Kahuta Tahsils of the Ráwal Pindi District, the maps of which are urgently required for forest purposes. The issue of the sheets had not been so rapid as was at first expected, but the Surveyor General is fully aware of the necessity for expediting this work. The revenue survey of the Sirsa District, begun in 1876, was finished in March 1879; and the party was then transferred to Jhelum. But although the survey of the latter district actually commenced, circumstances did not warrant its continuance during a time of some financial pressure, and when there were many more pressing duties for the Survey Department to perform. Settlement operations had so far advanced that a revenue survey, begun in 1879, could not have been effectively utilised as any check upon the settlement measurements. The work was accordingly given up, and the party brought under reduction.

7. Cadastral or field surveys continued or were begun in the North-Western Provinces, Bengal, Assam, and Burma. In the Banda District of the North-Western Provinces the work is nearly finished; in the Jaunpur District it is about half done; and a commencement was made in the districts of Ghazipur and Mirzapur. In Bengal the survey of the irrigation tracts of the Cuttack District, which had been undertaken for the Irrigation Branch of the Department Public Works to facilitate the collection of canal water-rates, was brought to a close by the creditable exertions of the party, who continued in the field till the middle of July, thus avoiding the necessity for another field season. The survey and settlement of the Khorda Government estate in the Pooree District had been found to be very costly; and, after much discussion, new arrangements were agreed upon, which did not, however, affect the procedure during the year under review. For the field season now closing the principles adopted were that, in the case of the remaining

villages requiring a cadastral survey, the professional party should execute a traverse survey of the village boundaries, and prepare skeleton maps of villages and of sub-divisions of villages. The Settlement Department were then to fill in the interior and topographical detail, except that hill tracts were to be mapped professionally on the 4-inch scale. In the Lohardugga District the work still considered necessary on the Barkagarh, Puthia, and Salem estates was completed; the party was broken up and its members transferred to Burma and elsewhere in August 1879. The cadastral survey of the Cachar District in Assam was undertaken for the purposes of the resettlement now in progress. It was at first desired to uphold the village boundaries according to the professional survey of 1864 to 1868 as the basis of the measurements; but it was subsequently determined by the Chief Commissioner of Assam that rigid adherence to these boundaries was only unavoidable in cases where the proprietary right in the land had been alienated. Many difficulties ensued, due in part, but not exclusively, to this change of opinion. The progress made was insignificant; and finally, the professional party was withdrawn, leaving only a small detachment to assist the Settlement Officer. The question of the best method upon which this survey should proceed has not yet been finally determined, although the Government of India have provisionally approved the system described at page 37 of the Report, pending the results of the present field season.

One of the chief events of the year was the institution of cadastral operations in the Hanthawaddy (late Rangoon) District of British Burma in view to the first regular settlement of the Pegu Division. A system of settlement is in process of creation in that Province, where the conditions of investigation are both novel and by no means closely allied to those of Northern and Peninsular India. A large outturn was not to be expected at first, the main object being to accumulate such experience as would serve to indicate the principles for future guidance. The determination of the unit of survey, whether it should be the field or the holding, an aggregate of fields, was a point involving opposite considerations of perhaps almost equal balance at first sight; and it has not yet been finally decided. It was, however, directed that during the season of 1879-80 the survey in the Hanthawaddy and Bassein Districts should be by fields; and when the results of this season are known, the unit of survey will be finally chosen.

8. Two "miscellaneous" surveys may be noticed—the one in the Kamrúp District of Assam, and the other in and around Darjeeling. The objects of the Kamrúp survey were to adjust areas and consolidate into compact blocks the rent-free and half rent-free estates held in small plots scattered throughout different villages. The work proceeded slowly, and little was done. It was assumed that in carrying out the consolidation no change would be made in the tenure of Government ryots whose holdings might be transferred to the rent-free estates; but on the Civil Court's determining that the ryot, in such a case, would lose his right of occupancy, the Chief Commissioner directed the discontinuance of such transfers save with the ryot's consent. He was of opinion that the remaining work could be effectually performed by ordinary *Amins* under the Extra Assistant Commissioner. This view was accepted, and the professional survey in the Kamrúp District has been discontinued. The principal operations of the Darjeeling party were a new large scale survey of the station of Darjeeling, the ascertainment of the boundaries of certain Government lands, and the mapping of land grants for tea culture. A geographical survey of Independent

Sikkim by the same party has been sanctioned; but this subject belongs to the narrative of the current year.

9. Geographical operations generally gained a wide extension from the political events of the year. Survey officers accompanied the several columns invading Northern and Southern Afghanistan and occupying the Kuram Valley. In Southern Afghanistan the chief results were surveys of the valley of Pishin, of the Kadanai District, to the North-East of the Khwaja Amran range, of the hitherto almost unknown tableland of Toba, to the North-East of Quetta, and of the country round Kandahar. Route surveys followed, and sometimes extended beyond the progress of the forces; amongst them may be mentioned the line from Roján *viâ* Bugti Dera to Lehri, the Bolán Pass, 150 miles of exploration through the new country between Pishin and the great central desert of Afghanistan, several routes from Quetta to Kandahar, the direct road from Kandahar to Khelat-i-Ghilzai, the Arghandáb Valley, a route from Kandahar to Girishk, and the now well-known Thal-Chotiali route from Balozai, North of Quetta along the Bori and Luni Valleys past Vitakri to Fort Munro on the British frontier. In the Kuram Valley a total area of some 3,000 square miles was mapped, the routes being taken at 1-inch to the mile, and the geographical work executed on the $\frac{1}{4}$-inch scale; the approximate limits were to the East, a line from Thal on the Kuram River to the Agram Pass on the Safed Koh range; to the North from the Agram Pass along the Safed Koh to the Shutargardan Pass, and to the West and South the water-shed of the Khost basin. Along the Kabul River and to the North of the Safed Koh range, the area surveyed was about 2,200 square miles, extending from Forts Michni and Jamrud near Peshâwar to the Surkhab River, West of Gandamak. A considerable amount of geographical information was also obtained to the North of Jellalabad in the Dasht-i-Gumberi plain and the Lughman Valley. Recognition of the skill, energy, and devotion displayed in these arduous undertakings by the officers of the Survey Department belongs to the military authorities, under whom the services were rendered; but, in reviewing the survey operations of the year, the Governor General in Council desires to place on record here his high appreciation of the results achieved by the survey officers in Afghanistan amid great difficulties and dangers. Conspicuous amongst them were Major Woodthorpe, Captain Leach, v. c., Mr. G. B. Scott, and the late Captain Samuells, whose untimely death from fever is much regretted. The excellent work and gallant conduct of Captain Sartorious also deserve mention, though that officer does not belong to the Survey Department.

10. At pages 52 to 55 of the Report the Surveyor General has summarised the experience gained regarding the sufficiency of the general organisation of the survey operations during the Afghan campaign. His remarks constitute the report required by the despatch of the Secretary of State noted in the margin; and the observations made on the duties and instrumental equipment of survey officers campaigning with an army in an unknown country will be of great value in the Department. No doubt it would be convenient, though perhaps seldom practicable, if considerable notice were given to officers about to be sent to join an army in the field, so that they could select their own instruments and men. But the Government of India concur with the Surveyor General in the opinion that the late campaign has shewn that much excellent work can be done by officers who have not possessed this advantage, "but have raced to the front

No. 290 (Military), dated the 16th October 1879, paragraphs 9 to 11.

as fast as they possibly could go, picking up men and instruments, camp equipage and horses, wherever they could find them on the road, and depending" for the further recruitment of their parties on the Natives, either of the frontier or of the invaded country itself.

11. The Appendix to the Report contains an account of three trans-Himalayan explorations. In Eastern Tibet some progress has been made towards the solution of the question whether the Sanpo River eventually enters the Brahmaputra or the Irrawaddy. The information obtained in 1875-76 by the explorer in South-Eastern Tibet would have been fuller had he not been discovered. The exploration in the Swat and Indus Valleys and the Kohistan between them has added much to the geographical knowledge of an interesting region as yet unvisited by Europeans.

In Gilgit Lieutenant-Colonel Tanner succeeded in mapping an area of 2,000 square miles on the $\frac{1}{4}$-inch scale.

12. Summarising the results of the year territorially with primary reference to the scene of the several operations, it appears from the foregoing paragraphs that in Afghanistan large additions were made to geographical knowledge. In the Punjab the revenue surveys of the Derajat and of the Murree and Kahuta Hills were continued. That of Sirsa had been finished; that of the Jhelum District was begun, but soon abandoned. The alluvial lands of the Jumna near the base of the Himalayas are being mapped. Cadastral parties were at work in the Banda, Jaunpur, Ghazipur, and Mirzapur Districts of the North-Western Provinces. Topography was in progress in the Meerut Division. In Bengal cadastral surveys were advanced or finished in the districts of Lohardugga, Cuttack, and Pooree. A special survey was undertaken in and around Darjeeling. The Kamrúp survey in Assam, also of a special character, came to an end. The Cachar cadastral survey was modified. The Sylhet topographical survey effected little. In Burma cadastral work for settlement purposes was actively taken in hand. Triangulation skirted a part of the coast of the Pegu Division, and extended from Tavoy into Siam. Trigonometrical work was also done in the South of the Madras Presidency, near the Coleroon and South Pennar Rivers. Mysore and many parts of Western India, the North and South Deccan, Khandesh, Guzerat, and Kattywar contributed to topography. There was triangulation in the Upper Sind Frontier and in Beluchistan. In Central India and Rajputana all the parties employed were topographical. Broadly it may be said that there was principal or secondary triangulation only at the extremities of the empire, in the South, on the Siamese frontier, and on and beyond the frontier of Sind. Revenue surveys were confined to the Punjab. Cadastral surveys proceeded in the North-Western Provinces, Bengal, Assam, and Burma; and the main areas under topographical delineation lay in the West, in British or Native territory. Geographical exploration extended beyond the limits of India. The Governor General in Council considers that the work of the year is satisfactory, and has been directed with judgment and ability by General Walker, the Surveyor General of India.

13. As regards tidal operations, instruments have been set up at Bombay, Kurrachee, Karwar, Madras, Vizagapatam, Paumben, and Beypore. Various other points and places have been visited with a view to ascertain their suitability for tidal stations. The tide-calculating machine, originally constructed for despatch to this country in order to aid Captain Baird, the officer charged with the superintendence of this work, in the preparation of tide-tables for each of the Indian ports, has been retained in England, so as to be

available for the requirements of the Admiralty and the Civil Engineers in charge of harbour works. The tide-tables for Indian ports will, therefore, have to be prepared in England, the necessary data being sent home.

14. Standing orders require that some explanation should always be given of the omission to carry out levelling operations in districts under revenue survey. The Report shews that revenue surveys, unlike topographical surveys, are not organised for the determination of heights as a part of the regular routine. If levelling is wanted, provision must be made for it by an additional agency, and the cost of this is separately met. During the year levelling was conducted only in the Banda District of the North-Western Provinces. The survey party of the Saháranpur and neighbouring districts does not execute any levelling, as the Irrigation Engineers have carried a full system of levels over those tracts. It is probable that levels will be taken, where necessary, during the course of the survey in British Burma.

15. The head quarter offices comprise the Surveyor General's Office, the Revenue Survey Office, the Lithographic Office, the Photographic Office, the Mathematical Instrument Office, all in Calcutta, and the Trigonometrical Survey Office at Dehra Dún. The five Calcutta offices are in separate buildings; but arrangements for bringing the Surveyor General's Office and the Revenue Office under one roof have at last been actually begun. It appears from paragraph 318 of the Report that more than half the present stock of maps for general issue is very insecurely housed. The Surveyor General should take early steps to remedy this state of things, and should, if necessary, submit proposals on the subject. It is satisfactory to observe that the original maps and records are being re-arranged on an improved system.

16. Four new plates of the Atlas of India were completed and published; 31 new quarter plates are in various stages of progress; and large additions have been made to 11 others. The map issues amounted to 28,737 maps of the value of Rs. 38,274, the persons supplied being for the most part officers of Government. The publication of the cadastral maps of the North-Western Provinces and Bengal shews good results. The sheets in hand up to 31st December 1879 numbered 28,452, of which, by the same date, 23,648 were published, the balance of 4,804 sheets chiefly pertaining to the Banda and Pooree Districts. There was much improvement in the rate of reproduction of the North-Western Provinces maps, the sheets printed off by the Photographic Office being 4,126 in number, or 566 more than in 1877-78.

17. The issues from the Mathematical Instrument Office were 18,410 instruments, valued at Rs. 1,27,800. The Survey Department was supplied with 7,470 instruments, priced at Rs. 51,000; and the residue met the wants of a variety of other Departments, the most numerous indents coming from the Department Public Works. The Surveyor General shews that the rates of local purchase average about 34½ per cent. above those at which instruments received from England are issued to the public service. The departmental manufactures were valued at Rs. 10,000. They consisted of instruments and appliances of simple construction; and the saving effected by manufacture as opposed to supply from the English market is estimated at Rs. 1,500. A systematic arrangement of the stock of instruments is in progress.

18. Volumes II., III., IV., and V. of the Account of the Operations of the Great Trigonometrical Survey have been published and

distributed. Volume VI. is well advanced, and other volumes are in hand. Of the synoptical volumes, giving a précis of the requisite results, both principal and secondary, for topographical and geographical requirements, the first six were published some years ago. Volumes VII. to XI. have lately been completed, but are not yet published. The completion of Volumes XII. and XIII. is anticipated during next year.

19. The Surveyor General, in the beginning of his Report, refers to the half-pay system under which officers whose services were not immediately required could be permitted to remain unemployed, but on the departmental list, up to a term of five years. This principle was acted on experimentally and in a few cases only. This system has now been discontinued under the orders of the Secretary of State.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	British Burma.
North-Western Provinces and Oudh.	Assam.
	Mysore and Coorg.

ORDER.—Ordered, that a copy of the foregoing resolution be communicated to the Local Governments and Administrations noted in the margin for information.

Also, that a copy of the resolution be forwarded to the Foreign and Military Departments and to the Surveyor General of India for information.

(True Extract.)

C. BERNARD,

Offg. Secretary to the Govt. of India.

R. D'R.—Home, Rev. & Agri. Dept. Press—No. 719—10-6-80—350.

1880

Home, Revenue & Agricultural Department.

SURVEYS.

RESOLUTION.

Nos. 2
181—14 .

Dated Simla, the 17th May 1880.

SUBJECT.

Review of the Report on the Operations of the Sur
India during 1878-79.

GENERAL REPORT

ON THE

Operations of the Survey of India,

COMPRISING

THE GREAT TRIGONOMETRICAL, THE TOPOGRAPHICAL, AND THE REVENUE SURVEYS UNDER THE GOVERNMENT OF INDIA,

DURING

1879-80.

PREPARED UNDER THE SUPERINTENDENCE

OF

MAJOR-GENERAL J. T. WALKER, C.B., R.E., F.R.S., &c.,
SURVEYOR-GENERAL OF INDIA.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING.
1881.

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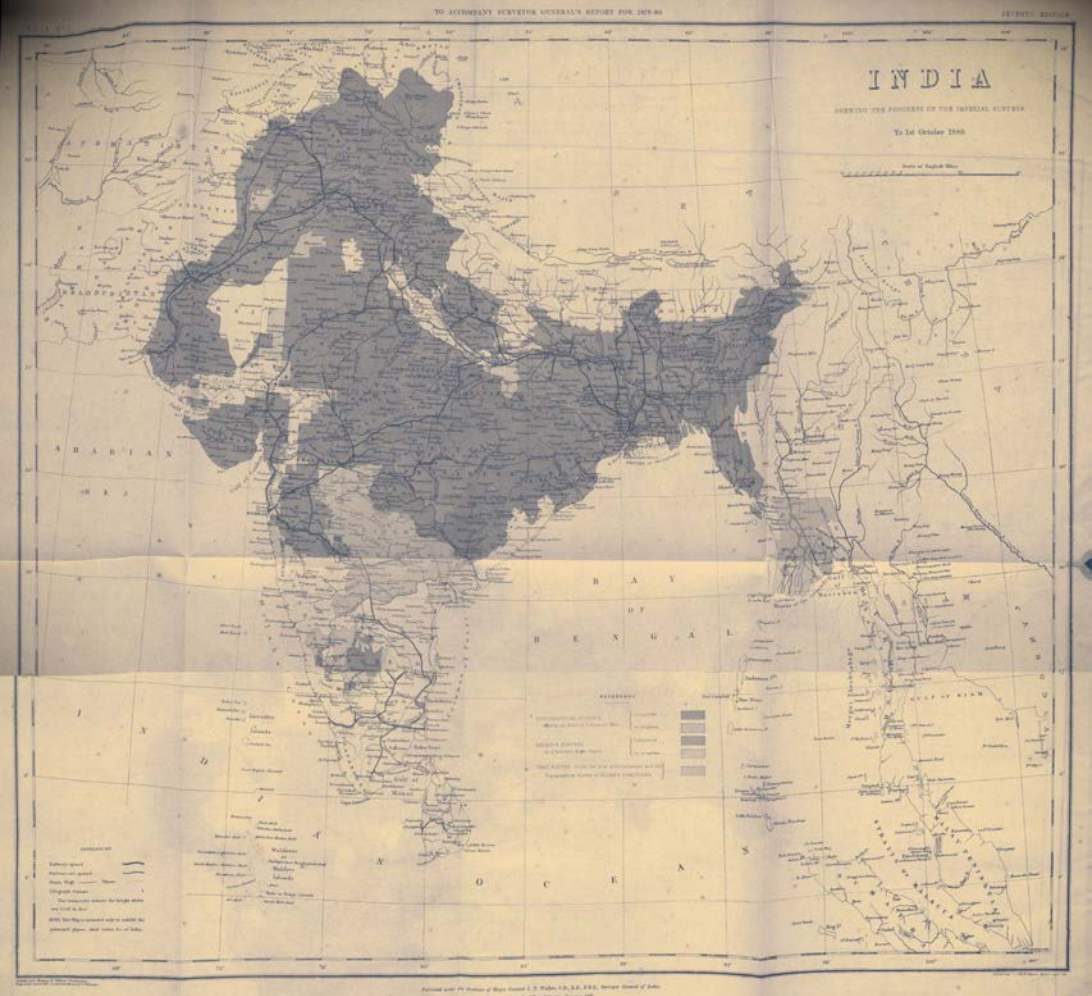
TO ACCOMPANY SURVEYOR GENERAL'S REPORT FOR 1883-84



GENERAL REPORT

ON THE

Operations of the Survey of India,

FOR SEASON

1879-80.

INTRODUCTORY.

THE general direction of the Department and the immediate supervision of the Trigonometrical and Topographical Branches, have been performed by Major-General J. T. Walker, C.B., R.E., Surveyor General. The immediate supervision of the Revenue Branch has been performed by Lieutenant-Colonel J. Sconce, S.C., Deputy Surveyor General.

2. The principal operations which have been carried out during the survey year under review, *viz.*, from 1st October 1879 to 30th September 1880, are as follows:—

Statement of Survey Operations and Parties.

Number in this Report.	Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party.	Remarks.
	Triangulation.			
I	Madras	Lieut.-Col. B. R. Branfill	Madras Party.	Principal Triangulation.
II	Eastern Sind	Capt. M. W. Rogers, R.E.	Bombay Party.	
III	,, Frontier	Capt. J. Hill, R.E.	Eastern Frontier Party	
IV	Burma	Mr. W. G. Beverley	Burma Party.	Secondary ,,
	Topography.			
V	Central India	Major E. H. Steel, S.C.	No. 1 Topographical Survey.	Topography on 1-inch scale, for reproduction on same scale.
VI	Khandesh	Capt. W. J. Heaviside, R.E.	No. 2 Topographical Survey.	
VII	Malwa	Major J. R. Wilmer, S.C.	No. 5 Topographical Survey.	
VIII	Sylhet	Major W. F. Badgley	No. 6 Topographical Survey.	
IX	Rajputana	Lieut.-Col. G. C. Depree, S.C.	No. 7 Topographical Survey.	
X	Mysore	Capt. G. Strahan, R.E.	No. 8 Topographical Survey.	
XI	Guzerat	Lieut.-Col. C. T. Haig, R.E.	Guzerat Survey.	2-inch scale for reproduction on same scale and reduction to 1-inch scale.
XII	Meerut Dn., N.-W. P.	Major W. H. Wilkins, S.C.	3rd Revenue Survey.	
XIII	Kattywar and Cutch	Major A. Pullan, S.C.	Kattywar and Cutch Survey.	2-inch scale, for reduction to 1-inch scale.
XIV	North Deccan and Konkan	Col. J. Macdonald, S.C.	10th Revenue Survey.	
XV	South Deccan	Major H. S. Hutchinson, S.C.	11th do. do.	
	Mauzawar or Village Survey.			
XVI	Rawalpindi and Dera Ismail Khan.	Lieut.-Col. D. Macdonald	1st Revenue Survey.	4-inch scale.
XVII	Khorda Estate, Bengal	Mr. J. Campbell	7th do. do.	
	Cadastral or Field Survey.			
XVIII	Banda and Mirzapore, N.-W.P.	Col. F. C. Anderson, S.C.	5th Revenue Survey.	16-inch scale, and Forest Survey on 4-inch scale.
XIX	Jaunpur, N.-W. P.	Mr. E. T. S. Johnson	6th do. do.	16-inch scale.
XX	Ghazipur, do.	Major W. Barron, S.C.	4th do. do.	
XXI	Hanthawaddy, Burma	Capt. J. E. Sandeman, S.C.	2nd do. do.	
XXII	Bassein, Burma	Major D. C. Andrew, S.C.	8th do. do.	

Statement of Survey Operations and Parties,—concluded.

Number in this Report.	Nature and Locale of Operation.	Name of Executive Officer.	Designation of Survey Party.	Remarks.
	Miscellaneous.			
XXIII	Darjeeling and Sikkim .	Lieut. H. J. Harman, R.E.	Darjeeling Survey.	Various scales.
	Geographical.			
XXIV 1	Northern Afghanistan .			
,, 2	Southern do. . .			
,, 3	Beluchistan . . .			
XXV	Trans-Frontier Explorations.			
XXVI	Surveys around Gilgit .	Lieut.-Col. H. C. B. Tanner.		
	Tidal Operations.			
XXVII	Indian Coasts . . .	Capt. A. W. Baird, R.E.		
	Leveling Operations.			
XXVIII	Bombay and Madras .	Ditto ditto.		
	Geodetic.			
XXIX	Southern India . . .			

3. The principal triangulation of all India, as originally designed by Colonel Everest—about the year 1832—with the approval of the Court of Directors of the Honourable East India Company, was intended to consist of a system of meridional chains of triangles at intervals of about 1° apart, tied together by longitudinal chains at about 6° apart, the whole being enclosed within a periphery formed by chains of triangles carried along the frontier and coast lines. The operations have been carried on in general accordance with this design. But the distance between the principal meridional chains which have been executed within the last 20 years has been materially increased; for it was found that chains at intervals of 2° to 3° apart would suffice as a basis for the general topography of the country. For similar reasons a chain of principal triangles on the west coast of the Peninsula, from Cape Comorin to Mangalore, which is now all that is wanted to complete the periphery of frontier and coast-line triangulation, may be dispensed with; it would extend from the southern extremity of the well-known Great Arc of Colonels Lambton and Everest—as recently revised and modernised—and close on the Mangalore longitudinal series, and thus it would nowhere be as much as 100 miles, nor more on an average than 50 miles, distant from the principal triangulations which have already been completed; moreover, it would cover a hill tract through the whole of which good secondary triangulations have already been carried—being in this respect unlike the twin series on the east coast which passes over forest-clad plains, very difficult to triangulate and never before operated in. Moreover, its completion is not necessary for geodetic purposes, as for them the present first class chains of triangles in its neighbourhood will amply suffice. It is solely desirable from considerations of regard for the general symmetry of the principal triangulation; but as it would employ a survey party for fully three or four years, its cost would altogether outweigh those considerations. Consequently, as the chain of triangles along the east coast, between Cape Comorin and Madras, which has been some years in progress, was completed during the present year, the principal triangulation may now be considered to be wholly finished in Southern India. In Northern India, only a small portion of a single (meridional) chain of triangles remains for execution, which will probably be completed within the next few months, and then the whole of the principal triangulation of the regions between Afghanistan and Burma, the Himalayan Mountains and the Indian Ocean, will be finished as regards the linear and angular measurements and the field operations generally; the reduction of the observations is well advanced, but about one-half still remains for completion.

4. The general outturn of the triangulation was as follows: Three chains of principal triangles of an aggregate length of 165 miles, furnishing 26 new stations—at three of which verificatory astronomical determinations of azimuth have been made—and embracing an area of 3,949 square miles; also various

chains of secondary triangles of an aggregate length of 150 miles, furnishing 33 new stations and 172 points, in an area of about 5,000 square miles, exclusive of a large amount of secondary triangulation in Siam and Sikkim, of which complete details have not yet been received.

5. The regular topographical operations—mostly on the standard scale of one inch to the mile and on the half-inch and two-inch scales—were carried on in continuation of the operations of the preceding year, in the same provinces and by the same parties. The general outturn of the topography was as follows:—

220	square miles	surveyed on the	¼-inch scale.
7,138	ditto	ditto	½ „
4,794	ditto	ditto	1 „
9,664	ditto	ditto	2 „
117	ditto	ditto	4 „

Two towns of an aggregate area of 20 square miles were surveyed, one on the 6-inch, the other on the 12-inch scale.

6. The Mauzawar or Village survey of the Murree and Kahuta Tahsils of the Rawalpindi District for the Forest Department has been completed; and the survey of another tract, the "Kala Chitta" range, also in the Rawalpindi District, for the same department, has been commenced. The village survey operations in the Dera Ismail Khan District have been continued. The forest survey, on the 4-inch scale, in the Banda District, has been completed. The Khorda Estate Survey Party—reduced in strength after completion of its cadastral survey operations—has surveyed a hilly portion of the estate on the 4-inch scale, where a cadastral survey was not required; and at the same time has completed the survey of the village boundaries in the area left for the measurement of fields by the settlement survey. This party has also surveyed, on the 32-inch scale, several detached hills within the settlement survey area.

No. 3 Revenue Party, which has been engaged chiefly on topographical survey, has also carried on a village survey of the alluvial lands in the bed of the Jumna River.

The total areas of these several operations are—

2,118 square miles surveyed in detail on the scale of 4 inches = 1 mile, but including 40 square miles of 32-inch survey in Khorda.
1,973 square miles of preliminary traversing.

7. A small area rejected from the forest reserves has been surveyed cadastrally in Banda, and the survey of the district has been completed. The cadastral surveys of Districts Jaunpur, Ghazipur and Mirzapur have been continued, as during the previous season, on the 16-inch scale. The cadastral survey of District Hanthawaddy in Burma has been continued on the 16-inch scale, but having the field as the unit of survey in place of the holding. A new party has been raised for the cadastral survey of the Bassein District, for which the 16-inch scale and the unit of the field have been adopted, as for Hanthawaddy.

The total areas surveyed by the Cadastral parties are—

2,692 square miles surveyed in detail on the scale of 16 inches = 1 mile.
1,581 square miles of preliminary traversing.

8. In Northern Afghanistan the advance of the British forces to Kabul and the occupation of the country up to August 1880 offered fresh opportunities for the extension of our geographical knowledge, which during the previous year had been limited to the western extremity of the Kuram and Jellalabad Valleys. In continuation of this work the survey has been extended westwards up to the Pughman range, and now embraces the Koh-i-daman, Logar, Hissarak, Wardak, Maidan and Lughman Valleys; several points have been trigonometrically fixed on the Hindu-Kush which will be of much assistance towards the rectification of existing maps.

9. In Southern Afghanistan the operations were somewhat restricted; but a rough reconnaissance was made of a portion of the country between the Khakrez Valley and Girishk, and the surveys of the country around Kandahar were added to and improved as far as possible. A very useful and important route through the Khushk-i-Rud and northern portion of the Tarnak Valleys on northwards through the Ghazni Valley over the Shere-i-darra Pass, and into Wardak, was completed; and as this establishes a connection between the

surveys in Northern and Southern Afghanistan, and furnishes the positions of several important places, it will afford material aid in rectifying the old maps of the country between Kandahar and Kabul.

10. In Beluchistan a rough reconnaissance was effected of the country situated within the triangle formed by Quetta, Thal-Chotiali and Sibi; it is more or less incomplete, as the country was in an unsettled state, and the surveyors could only pass along the routes traversed by troops; but around Sibi, Dadar and a portion of the Lower Bolan, a fair amount of good topography has been obtained.

11. The combined operations in Northern and Southern Afghanistan and in Beluchistan furnish a total area of about 16,000 square miles of new geography, of which about two-thirds appertain to Northern Afghanistan.

PART I.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE DEPARTMENT.

TRIANGULATION.

I.—THE MADRAS COAST SERIES.

12. The primary object of this chain of triangles was the completion of the principal triangulation in Southern India by a regular series between Madras and Cape Comorin, with a branch series from Rámnád *viâ* Rameswaram and the adjacent islands of Palks' Straits for the connection of the Ceylon Survey with that of India. Triangulation had been commenced in the southern portions of the Peninsula, by Colonel Lambton, at the beginning of the present century, and it had been carried down the coast from Madras to Negapatam; but it simply consisted of a narrow chain, following the coast line and avoiding the interior, which is flat and covered with trees, and was found to be altogether too difficult to be touched during those early days of the trigonometrical survey, when as yet no method of taking the operations through tracts of forest had been devised; thus, a great blank in the triangulation has waited for the better part of a century to be filled in, and this work, which was commenced a few years ago near Cape Comorin, has now been completed.

Personnel

Lieutenant-Colonel B. R. Branfill, Deputy Superintendent 2nd grade.
Mr. C. D. Potter, Assistant Surveyor 1st grade.
„ A. H. Bryson, „ „ 3rd „

13. The principal operations of the present year consisted in the measurement of the angles of three polygonal figures, covering the space between the terminal side of the triangles of last year, which is situated a little to the north of the parallel of Pondicherry, and a side of the triangles near Madras which are situated at the eastern extremity of the Madras longitudinal series. Observations were taken at 15 principal stations, of which 11 were newly fixed; the direct distance spanned was 68 miles; 82 secondary stations and points were fixed; and an area of 2,001 square miles was covered by the principal and secondary triangulation. Astronomical observations were taken at two of the principal stations, partly for the verification of the azimuth, and partly in order to throw light on the probable amount of the local attraction in the direction of the prime vertical on the coast line; for this is a matter of much interest in connection with the question of the relations between the density of the strata of the earth's crust under continents and the density under the bed of the ocean.

14. Secondary chains of triangles were carried from the main chain to fix the positions of the light-houses at Pondicherry and Negapatam, and various other points which were too far away from the principal stations to be observed from them. These secondary chains passed over a thickly-wooded country, and could not have been executed at a moderate cost had it not been that there were lofty temples—commonly called Gopurams—in some of the intermediate villages, from the summits of which mutual observations could be taken; thus, the delay and expense of cutting lines to open out the rays between the stations, were avoided. To reach the summits of the temples was, however, in all cases a more or less difficult matter, as there were no staircases leading

up to them; ladders had invariably to be lashed outside,—in one case to a height of 103 feet—the climbing over which was very perilous; and as the roofs were always so ricketty that the movement of an observer round his theodolite would cause much vibration and deteriorate the observations, a platform resting on the walls had to be erected for the observer in each instance.*

15. The principal triangulation was finished unusually early in the field season, as the country was generally very favourable for the operations. After its conclusion Colonel Branfill proceeded to the west coast to connect the secondary triangulation which Colonel Lambton had brought up from Cape Comorin, over the hills of Travancore and Cochin to Ponâni, early in the present century, with the secondary triangulation—known as the Malabar Minor Series—which was brought down from the Mangalore Longitudinal Series in the year 1873-74. The connection was satisfactorily accomplished, rendering any further triangulation in this quarter unnecessary, for the reasons which have been already stated at paragraph 3 of this Report.

16. Colonel Branfill's operations of the present year closed with sundry observations for effecting a better connection of the triangulation on which the topography of the Nilgiri Hills is based, with his principal triangulation. This has completed the modern operations in Southern India, the greater portion of which have fallen to his share, and have been accomplished with much skill, energy and perseverance. His future work will be to complete what remains to be performed of the principal triangulation in Northern India, and to supervise the measurement of a base line in Tenasserim at the southern extremity of the Eastern Frontier Series of principal triangles.

II.—THE EASTERN SIND SERIES.

Personnel.

Captain M. W. Rogers, R.E., Officiating Deputy Superintendent 3rd grade.
Mr. W. C. Price, Surveyor 4th grade.
" C. P. Torrens, Assistant Surveyor 2nd grade.

17. Having completed the operations on which he had been engaged in Southern Afghanistan in connection with the recent military movements, and which included the execution of a chain of triangles between Quetta and Kandahar, Captain Rogers returned to Sind to resume the principal and secondary triangulations which had been suspended in 1878, when war with Afghanistan was declared. While returning he was much delayed for want of transport, all available animals being required for the army; and when he arrived at Hyderabad, where his principal instruments had been left in store, he was further delayed, because none of those useful men called 'hammals' or 'bearers' were to be obtained for the carriage of his large theodolite, all persons of this calling having either joined the army, or deserted the country through fear of being required to do so. Thus, it was necessary to wait until bearers could be brought up from Poona before the operations could be commenced.

18. The amount of work remaining to be completed on the principal series of triangles was what it might have been just possible to accomplish in a long field season and under a very favourable combination of circumstances, by a survey party fresh and in full vigour after some months' residence in recess quarters. Under existing circumstances Captain Rogers and his party, who had just returned from field operations extending over a year in Afghanistan, could not be expected to accomplish more than half of what remained to be done; but as this would secure the completion of the whole by the end of the following year, the duty was a very appropriate one for him to take up on his return from Afghanistan. He took final observations at 14 principal stations, forming two double (or two-centered) polygons; the area covered by the principal triangulation was 1,278 square miles, and the direct distance spanned was 64 miles. An azimuth of verification was also determined by star observations. The chain of secondary triangles connecting Khelat with Quetta was completed, and is serving as a very valuable basis for such topographical operations as are being carried on from time to time in this region.

19. Captain Rogers went to Europe in April, making over charge of his party to Mr. Hennessey, who has supervised the reduction of the observations and the preparation of the charts of triangulation, in addition to his regular

* This work fell principally to Mr. Potter, whom Colonel Branfill highly commends for his skilful performances and his good management in dealing with the Temple authorities.

duties in connection with the Computing Office at the Head-Quarters in Dehra-dun. This work has been taken up in the order which was most desirable to furnish final data for the survey operations in Southern Afghanistan and Beluchistan; *viz.*, *1st*, the series from Jacobabad to Quetta; *2nd*, the series from Quetta to Khelat; *3rd*, the series from Quetta to Kandahar; *4th*, the triangulations around Kandahar and in the Khakrez Valley. The three first have been finally disposed of, but the fourth will probably be largely supplemented by observations taken subsequently by Major Leach, V.C., R.E., and by Lieutenants Talbot and Longe, R.E.*

III.—EASTERN FRONTIER SERIES.

20. The party employed in the Eastern Frontier had been chiefly engaged during the previous year on the chain of secondary triangles which was intended to connect Bangkok, the capital of Siam, with the Indian triangulation. The programme of the operations for the present field season was for Captain Hill to complete the triangulation in Siam, while Mr. Beverley extended the chain of principal triangles which is known as the Eastern Frontier Series, down into Lower Tenasserim, and selected a suitable site for the measurement of a base line there at the southern extremity of the British territories in the Malayan Peninsula.

Personnel.
Captain J. Hill, R.E., Officiating Deputy Superintendent 3rd grade.
Mr. H. Beverley, Surveyor 1st grade.
„ J. Low, Surveyor 2nd grade.
„ J. F. McCarthy, Assistant Surveyor 3rd grade.

21. The ill-health, both of Captain Hill and Mr. H. Beverley, on whose presence the successful prosecution of the operations mainly depended, has materially interfered with the progress of the operations. Captain Hill was obliged to go to England in the summer of 1879, and this prevented him from reaching Bangkok in time to commence the field operations before the end of January, when the most favourable time of the year for observing distant objects was nearly over. The triangulation had been carried eastwards in the preceding year to the edge of the alluvial plains in which Bangkok is situated, and which are so thickly covered with trees that it seemed almost impossible to extend it over them without much line cutting, which, for obvious reasons, would have been very undesirable, both from a political point of view, and because very costly. Fortunately, a careful reconnaissance of the ground enabled Captain Hill to discover certain lofty temples and the chimney of a deserted sugar factory, the summits of which were mutually visible over the tops of the trees, though only in very clear weather, as the distances were considerable. No observations could be taken until the rains began to fall, and then they were speedily completed. A large number of observations have been taken from the stations of the triangulation, fixing several hill peaks on both sides of the Gulf of Siam, all the chief pagodas and flagstaffs in Bangkok, and various objects in the towns of Pechbooree, Tachin and Paknam. Captain Hill cordially acknowledges the valuable assistance he received from the Siamese Government, and from Mr. Palgrave, the British Consul at Bangkok, and his assistants, Messrs Newman and Gould.

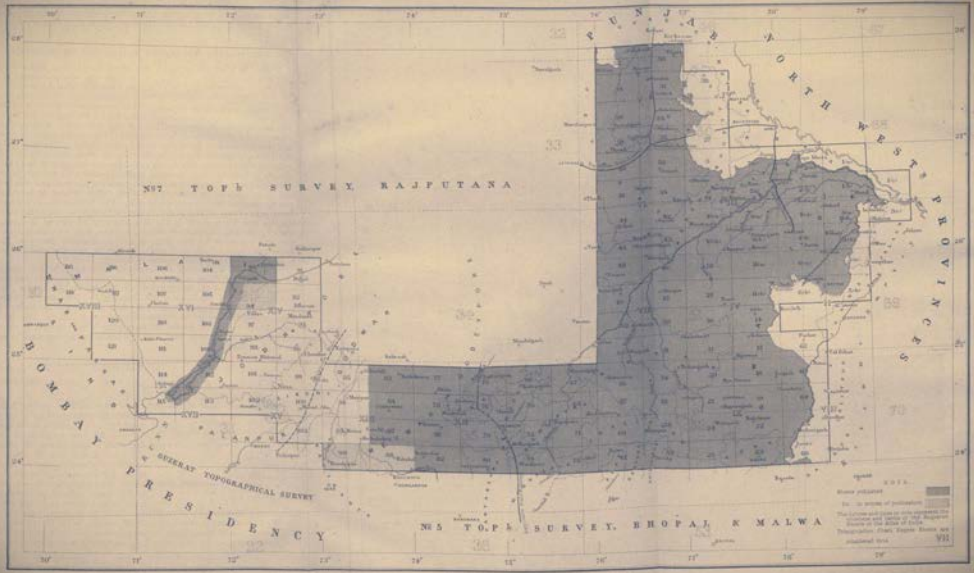
22. Mr. Henry Beverley commenced his field operations in November. But after a few weeks spent on the measurement of the principal angles, his health broke down, and he had to proceed to Mergui for medical advice. He had taken observations at five principal stations, and tried hard to get to the sixth station in order to take the few observations which were remaining to complete two quadrilateral figures; but his strength failed him, and, greatly to his sorrow, he had to give up work with his last figure still incomplete. He had been stricken with a serious illness, which from the first was pronounced by the doctors to be fatal, and, through having a naturally very strong constitution, he rallied occasionally and lived on until the 22nd June, when his working days were over and he was never again able to put hand to an instrument. He entered the Great Trigonometrical Survey in the year 1855, had served 25 years, and was one of the most hard-working and valuable men in the Department; for his heart was

* Captain Rogers reports that Mr. Price has proved himself, as of old, a good and trustworthy assistant, who does his work cheerfully and well; also that Mr. Torrens did good work in the Kelat Series, under exceptionally trying circumstances.

No. 1 PARTY.

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.


PUNJAB & NORTH WEST PROVINCES
No7 TOPL SURVEY. RAJPUTANA
BOMBAY PRESIDENCY
GUJERAT TOPOGRAPHICAL SURVEY
No5 TOPL SURVEY. BHOPAL & MALWA

Compiled from the Surveys of Major Stevens, C.V. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1865.

always in his work, at which he laboured with unflinching assiduity and perseverance, and almost invariably with much success, though his operations were often carried on in malarious tracts, under great disadvantages, and with much detriment to his health. His loss is much to be regretted.*

IV.—THE SECONDARY TRIANGULATION IN BURMA.

23. The triangulation which was being carried from Rangoon to the two beacons that were constructed on the main land opposite the Krishna Shoal, after the disappearance of the Krishna Lighthouse, had progressed very slowly in the preceding year. Mr. Hughes, the Surveyor who was employed on it, expressed his inability to complete it in another season, owing to the difficulties to be encountered; the country was quite uninhabited, and was covered with dense forest and jungle through which lines had to be cut in all cases to open out the rays between the trigonometrical stations. The triangulation was therefore abandoned, and a traverse was carried up to the beacons along any footpaths and openings which presented themselves in the forest. This being a much easier matter to perform, was accomplished in a few weeks; and though it is not as accurate as a triangulation, it may be considered sufficiently accurate for the purpose in view. The traverse was so executed as to form part of one of the main circuits on which the cadastral and revenue surveys now being made in the Hanthawaddy District of Rangoon, by the survey party under Captain Sandeman, will be based; for this purpose it was executed conjointly by Mr. Hughes, and an Assistant Surveyor, Mr. G. E. Parker, of Captain Sandeman's party, both going over the same line independently and comparing results, station by station.

Personnel.

Mr. W. G. Beverley, Officiating Assistant Superintendent 2nd grade.
„ J. O. Hughes, Assistant Surveyor 2nd Grade.

24. Mr. W. G. Beverley was employed throughout the field season on the secondary triangulation around and to the north of Bassein; the outturn of work was small and the triangulation was left incomplete, because, under the supposition that it was finished, Mr. Beverley had been directed to proceed to Mergui to take charge and supervise the field operations of the Eastern Frontier Party, which had lost its executive officer through illness. This he did not succeed in doing, merely joining the party after it had returned to recess quarters; thus, he would have been better occupied had he remained to complete his work in Bassein.

TOPOGRAPHY.

V.—GWALIOR AND CENTRAL INDIA SURVEY (No. 1 TOPOGRAPHICAL PARTY).

25. The operations of this party were almost entirely confined to the area between the parallels of 24° 0′ and 24° 30″ north latitude, and between the meridians 73° and 74° east longitude, the exception being a small tract in the vicinity of the Luni River, east of Sindri. The results of the season's work are represented by 1,287·4 square miles of detail survey on the scale of 1 inch = 1 mile, and by 270 square miles of triangulation, the latter being required to cover a gap in the triangulation of previous years in the vicinity of the small cantonment of Kotra.

Personnel.

Major E. H. Steel, S.C., Officiating Assistant Superintendent 1st grade, in charge.
Mr. W. J. Cornelius, Assistant Surveyor 1st grade.
„ P. J. W. Doran, „ „ „ „
„ C. T. Templeton, „ „ 2nd „
„ A. Kitchen „ „ 3rd „
„ G. P. Tate „ „ 4th „
Sub-Surveyor J. R. Harris,
„ Abdul Guffar (transferred to Kandahar-in April)
and 4 others.

26. This outturn of area is exceptionally small; but as the greater portion of the work lay in exceedingly intricate ground, the lower features of which have been described by Major Steel, as resembling a petrified stormy sea, a

* Captain Hill intimates that the site for the proposed base-line in Southern Tenasserim which was selected by Mr. Low is very unpromising, and that further reconnoissance will probably lead to the discovery of a better site. He reports most favourably of Mr. McCarthy's operations in Siam, and states that the local officials are so pleased with Mr. McCarthy that they have offered him an appointment under the Siamese Government, which he will take up as soon as his services can be spared from this Department.

larger outturn could not well have been expected. The work has been very carefully executed and examined in the field by Major Steel.

27. The fair mapping of standard sheets Nos. 88, 90, and 94 has been completed, and the maps are now in course of publication.

28. Captain C. Strahan, R.E., having returned from furlough, was posted to this party in time to commence the field operations of the current working season. The party will be engaged on the detail survey of sheets Nos. 86 and 89, on the scale of 1 inch = 1 mile, and on a survey of the cantonment of Kotra on the scale of 8 inches = 1 mile. The work on the smaller scale will again fall in very intricate ground.*

VI.—KHANDESH AND BOMBAY NATIVE STATES SURVEY (No. 2 TOPOGRAPHICAL PARTY).

29. This party has been engaged in topographical work solely on the scale of 2 inches to the mile in the Khandesh District; the mapping on the 1-inch scale of the country north of Khandesh, including the Satpura Range and the Nerbudda Valley, having been completed last year. With a view to assist the settlement officers, the positions of the trijunction pillars of all the villages are fixed, generally by traversing; and are shown on the fair maps together with the village boundaries.

Personnel.

Captain W. J. Heaviside, R.E., *Deputy* Superintendent in charge.
Mr. A. G. Wyatt, Surveyor, 4th grade.
„ J. A. Barker, Assistant Surveyor, 1st grade.
„ F. E. Warde „ „ 2nd „
„ G. Vander Beck „ „ 3rd „
„ E. Graham „ „ 3rd „
„ C. George „ „ 4th „
Shek Omar, Sub-Surveyor,
Mr. F. Rosario „
Hyder Ally, „
and four others.

30. The triangulation this year was carried on by Mr. Wyatt in the southern portion of the District in the Talukas of Erandole, Páchora, Jámner and Nasirábád, and covered an area of 1,281 square miles, most of which is under cultivation.

31. Traversing was extended over the area triangulated last year in the south-east portion of Khandesh, including the Talukas of Bhusawal and Jámner, and also in the Pimpalner and Nandurbár Talukas, west and north-west of Dhulia. Altogether 1,151 linear miles of traversing were executed, by which 753 trijunction pillars were fixed; affording the means of determining the heights of 184 traverse stations by the simple and comparatively accurate method of observing from traverse stations to trigonometrical stations, the heights of which were known, the distances between the trigonometrical and the traverse stations being worked out from the difference of the horizontal co-ordinates.

32. The detail survey was carried on in the Pimpalner and Nandurbár Talukas, lying west and north-west of Dhulia. Sheet 38 was completed with an overlap to the south and west, of 1 mile; portions of sheets 37 and 34 were likewise surveyed. The total area of detail survey executed is 827·4 miles.

33. The country in sheet 38 embraces the upper basin of the Pánjhra Valley; the uplands are about 2,000 feet above sea-level with scattered groups of Bheel huts and but few villages. In the northern portion of the sheet a good deal of the country is very hilly and but sparsely inhabited: to the south a narrow rugged range, a spur of the Sáhyádri hills separates Khandesh from Násik with peaks of columnar basalt standing up 2,000 feet above the Pánjhra Valley; on the west the Sáhyádri hills covered with tree forest run northwards sloping away westwards to the Dangs. In sheet 37 the country is more level and more open. In sheet 34 the north-east portion of the country near the banks of the Tapti River is a flat open plain of black soil, on which a great deal of wheat is grown: further west the country is covered with low dhâk jungle, which, however, is being gradually cleared off, and in some places with heavy tree forest. The southern portion of this sheet is in strange contrast to the north-east portion, the prevailing characteristics being low hills covered with grass and tree forest with but little cultivation.

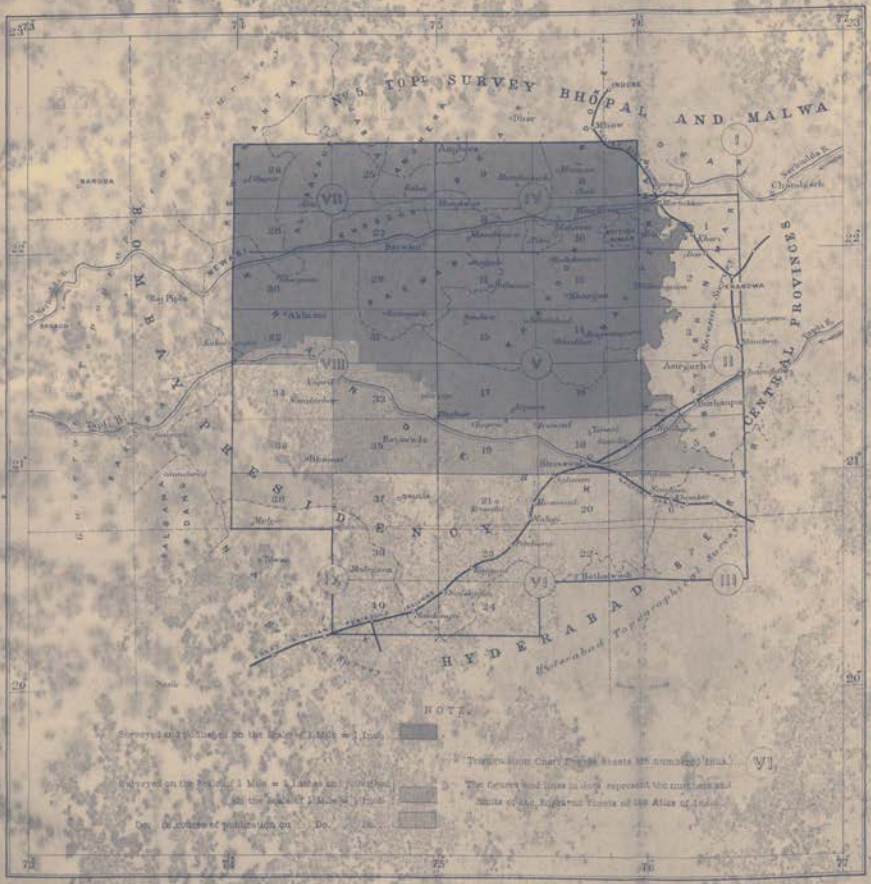
34. The survey is carried on under great disadvantages in sheets 34 and 36, as that part of the country is deemed very unhealthy until the month of February, and by that time water has become scarce: the heat is very great in

* Major Steel mentions Mr. Cornelius as specially worthy of praise; reports favourably of the other European assistants; and commends Sub-Surveyors Abdul Guffar, James Nathaniel, and Abdul Aziz.

No. 2 PARTY.

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES SURVEY,

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.

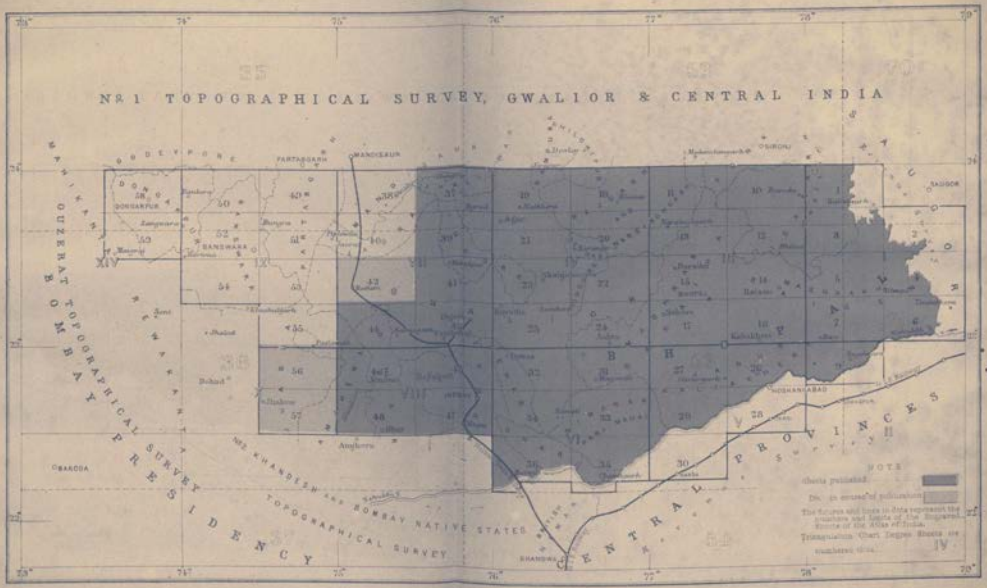

No. 5 TOPL SURVEY
BHOPAL AND MALWA
CENTRAL PROVINCES
BERAR
HYDERABAD
BOMBAY PRESIDENCY
BARODA
Indore
Amarkantak
Hyderabad Topographical Survey
NOTE.
Surveyed and Published on the Scale of 1 Mile = 1 Inch.
Surveyed on the Scale of 1 Mile = 1 Inch and Published on the Scale of 1 Mile = 1 Inch.
Do. do. reduced publication on Do. Do.
Transmission Chart Four Sheets (in numbers) thus VI.
The Square lines in dots represent the numbers and limits of the Regional Sheets of the Atlas of India.

Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S. Surveyor General of India,
at the Surveyor General's Office, Calcutta, December 1890.

No. 5 PARTY.

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

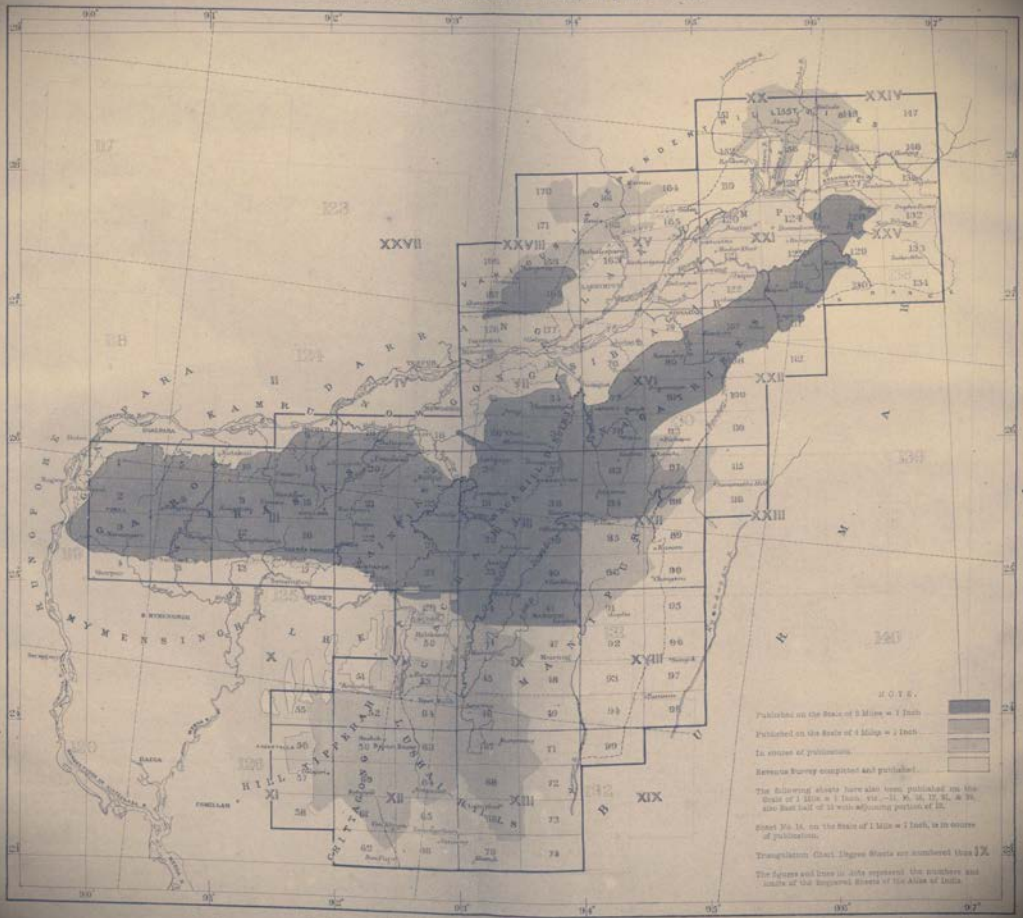


Published under the direction of Major-General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1881.

No. 6 PARTY.

INDEX TO THE SHEETS OF THE GARO, KHASI, AND NAGA HILLS TOPOGRAPHICAL SURVEY,

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile, and ¼ Inch = 1 Mile.



Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India, at the Surveyor General's Office, Calcutta, October 1880.

such low-lying ground as the hot weather advances, the low hills and forest shutting out all breeze.

35. Standard sheet 38 has been mapped during the recess, and is now in course of publication.

36. The following is now the state of progress of this survey :—

Area surveyed up to date, 13,663 square miles.
Area remaining for detail survey, 4,017 square miles.

37. During the current field season the triangulation will be carried over the south-western portion of the Khandesh District, extending over an area of a little more than 1,200 square miles, and the detail survey on the scale of 2 inches = 1 mile will be continued in the eastern part of the Khandesh District, in portions of standard sheets 6, 7, 20 and 22, and in portions of sheets 34, 36 and 37 on the north-western part of the District.

VII.—BHOPAL AND MALWA SURVEY (No. 5 TOPOGRAPHICAL PARTY).

38. As stated in paragraph 48 of last year's report, this party was to have been employed on the triangulation of the ground falling between Latitude 23°—24° and Longitude 74°—75°, and on the detail survey on the scale of 1 inch=1 mile of the tract shewn on the index maps by standard sheets 55, 56 and 57, and on the survey on the scale of 6 inches=1 mile of the City of Dhar. The party was late in taking the field, and it was found that the difficulties of the ground to be surveyed in detail were too great to admit of the programme being carried out in the manner anticipated; the area designed for triangulation was consequently very considerably reduced, in order that more time might be made available for the detail survey; notwithstanding this, the area surveyed in detail fell short of the expectations entertained at the commencement of the field season.

Personnel.

Major J. R. Wilmer, S.C., Officiating Assistant Superintendent 1st grade, in charge.
Mr. D. Atkinson, Surveyor 2nd grade.
„ C. F. Hamer „ 4th „
„ E. A. Wainwright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen „ „ 2nd „
„ W. H. Lilley „ „ 2nd „
„ G. R. Copping „ „ 3rd „
Sub-Surveyor Prem Raj
„ Harlall Sing
and three others.

39. The triangulation was extended over an area of 1,019 square miles by Major Wilmer, and the detail survey of sheets 56 and 57 and portions of sheets 42 and 55, in all embracing an area of 1,408 square miles, consisting almost entirely of intricate hilly country covered with jungle, was completed on the scale of 1 inch = 1 mile. The city and environs of "Dhar" covering an area of 8·34 square miles, were surveyed on the scale of 6 inches to the mile, and the plan is now in course of publication. The results of the 1-inch work will admit of sheets 42, 56, and 57 being published.

40. The state of the work of this party up to date is as follows, *viz.*:—

Area actually surveyed, 22,842 square miles,
„ remaining for survey, about 5,700 sqaure miles,

of which about 2,800 square miles have been prepared by triangulation in advance for future detail survey.

41. During the current field season, the triangulation being well in advance of the detail survey, will only be extended over small portions of the tracts falling in sheets 49 and 51. The detail survey on the 1-inch scale will be continued over the remaining portion of sheet 55, and over sheets 38 and 40; and surveys on the scale of 6 inches = 1 mile will be made of the Cities of Ujjain, Rutlam, and Jhabua.

VIII.—KHASI AND GARO HILLS SURVEY (No. 6 TOPOGRAPHICAL PARTY).

42. This party was delayed somewhat in taking the field, by the difficulty of collecting coolies among the Khasias, on whom the party entirely depends for carriage. So many of them had been taken for service with the troops on the expedition to the Naga Hills, that Major Badgley had to search far and wide before he could collect a sufficient number for his requirements. The party was obliged

Personnel.

Major W. F. Badgley. Officiating Deputy Superintendent, 3rd grade, in charge.
Mr. A. W. Chennell, Surveyor 4th grade.
„ J. McCay, Assistant Surveyor, 3rd grade.
„ A. W. Smart, „ „ 3rd „
„ D. Campbell, „ „ 4th „
Sub-Surveyors, Munshi Shah Nasirudin,
and four others.

to leave the field earlier than usual, on account of the heavy rains and floods which occurred at the latter end of March. These circumstances tended to reduce the outturn of work below the usual quantity.

43. The objects of the year's work were,—the continuation of the survey of waste lands, which have been, or may be, taken up for tea cultivation, and of the forest reserve lands in the south-east corner of the Sylhet District,—and the survey of a portion of Hill Tipperah to the east of Agartollah.

44. The triangulation of these tracts having been almost completed in previous seasons, scarcely anything more than the detail survey remained to be done; 102 square miles of waste land were surveyed on the scale of 2 inches to the mile; 210 square miles of forest reserve were surveyed on the scale of $\frac{1}{2}$ inch to the mile; and 220 square miles were surveyed on the scale of $\frac{1}{4}$ inch to the mile in Hill Tipperah. The whole of the work was in country of a very difficult character, covered in some parts with dense forest and thick undergrowth, and in others consisting of swamps covered by high reeds. A great portion of the work had to be done from a succession of platforms in trees, sometimes nearly 100 feet above the ground, and by chain measurements along the beds of streams. The season was unhealthy, cholera broke out in several parts of the tracts under survey, and Major Badgley reports the death of 12 of his menials from that and other diseases.

45. During the current field season Major Badgley will be engaged on the survey on the scale of $\frac{1}{2}$ inch to the mile of a portion* of Hill Tipperah between the Lungai Valley on the east, and "Koilashar and Hudgajceah" on the west, an area of about 230 square miles, and will continue the survey on the scale of 2 inches to the mile of the six portions referred to in paragraph 56 of last year's report.

* Said by mistake in last year's report to be required on the $\frac{1}{4}$-inch scale.

IX.—THE RAJPUTANA SURVEY (No. 7 TOPOGRAPHICAL PARTY).

46. This party assembled at Delhi on the 10th October, and in accordance with the programme laid down in paragraph 61 of last year's report, proceeded to extend the triangulation over the northern portions of the tracts falling in degree sheets XV and XVI, embracing an area of 690 square miles. The area previously prepared for detail survey was so large that no farther triangulation for the work on the $\frac{1}{2}$-inch scale was necessary; the only other triangulation required was that in connection with the survey of the city of Bickaneer.

Personnel.

Lieutenant-Colonel G. C. Depree, S.C., Deputy Superintendent 1st grade, in charge.
Mr. G. A. McGill, Surveyor 2nd grade.
" E. S. P. Atkinson, Surveyor 4th grade.
" J. H. Wilson, Assistant Surveyor 2nd grade.
" W. C. G. Barkley, Assistant Surveyor 3rd grade.
" R. W. Senior, Assistant Surveyor 4th grade.
Sub-Surveyors, Baboo Modhusudan Dutt, Munshi Esuf Sharif, and six others.

47. The detail survey on the scale of 1 inch = 2 miles was extended over an area of 6,928 square miles in degree sheets marked XIII, XIV and XV on the index map. The country thus surveyed is described by Colonel Depree as almost entirely an uninteresting desert, the only variety being found in the salt works at Sar, and in the sandstone quarries of Khari. In the former, a coarse salt is produced by solar evaporation, and in the latter a stone of good colour and of compact texture, of which the stratum is horizontal and close to the surface.

48. The city of Bickaneer was also surveyed and mapped on the scale of 12 inches = 1 mile. The results of the season's work will admit of the publication of four maps on the scale of $\frac{1}{2}$ inch to the mile, *viz.*, the northern half of degree sheet XIII, the northern and southern halves of degree sheet XIV, and the southern half of degree sheet XV.

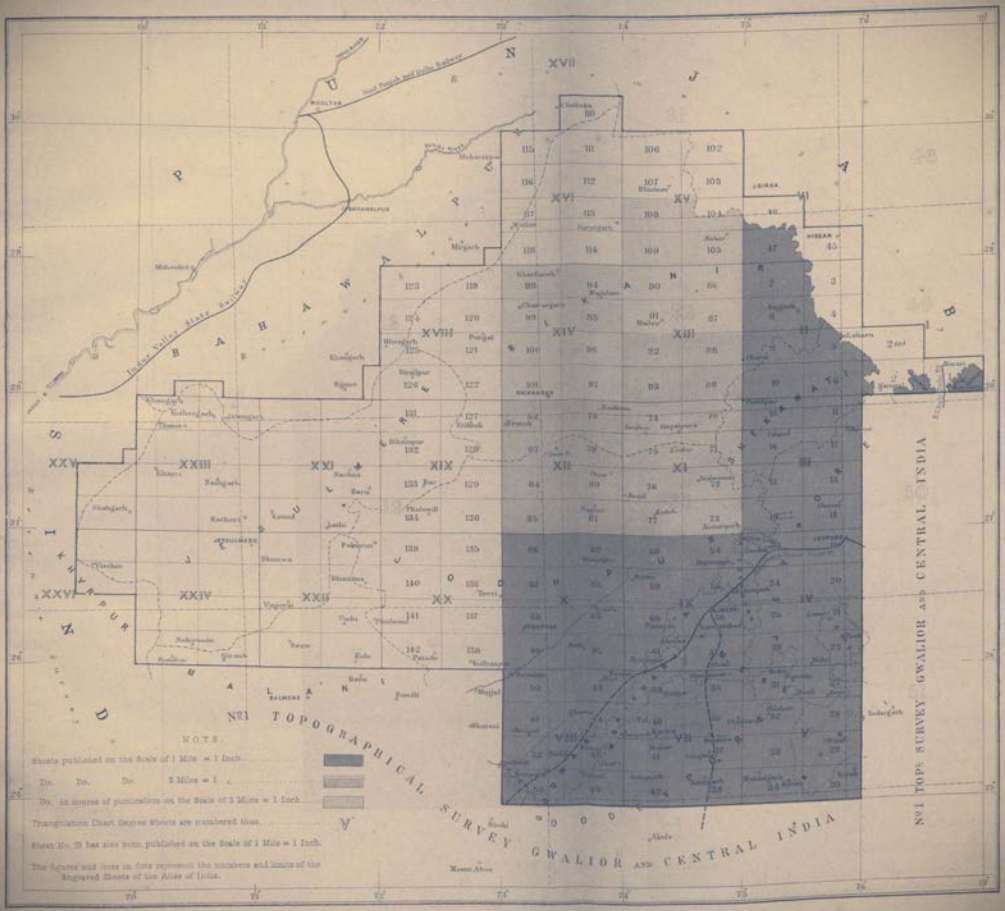
49. During the current season, part of this party will be employed in Rajputana and the remainder in completing the surveys of the cantonments of Dagshai and Solon, as already sanctioned by the Government of India.

50. In Rajputana, a large area, about 8,000 square miles, having been prepared for detail survey, a comparatively small amount of work of this nature will be required, and in consequence the triangulation will only be continued in the western portion of degree sheet XX, and perhaps in the southern portion of degree sheet XIX. The detail survey on the scale of $\frac{1}{2}$ inch = 1 mile will be carried on in degree sheets XV and XVI. The survey of the cantonments

No. 7 PARTY.

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY,

On the Scales of 1 Inch = 1 Mile and ¼ Inch = 1 Mile.

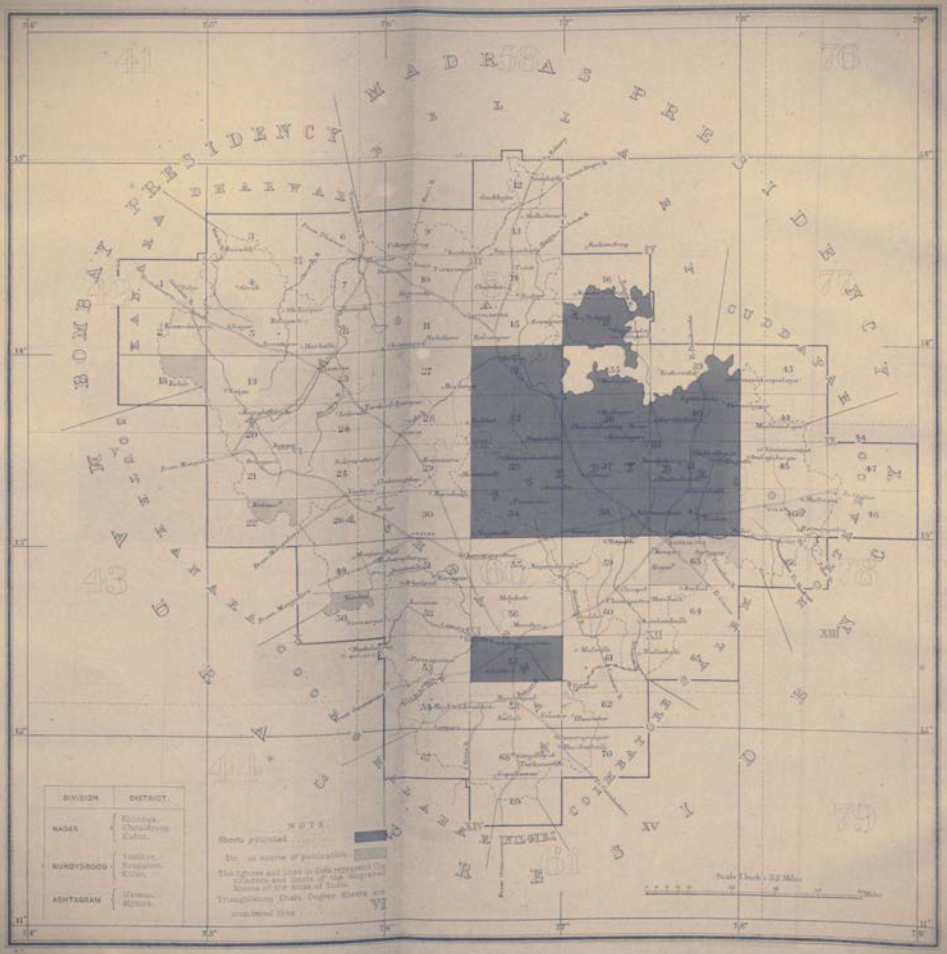

No. 1 TOPOGRAPHICAL SURVEY GWALIOR AND CENTRAL INDIA
No. 1 TOPO. SURVEY GWALIOR AND CENTRAL INDIA
NOTE.
Sheets published on the Scale of 1 Mile = 1 Inch.
Do. Do. Do. 2 Miles = 1 "
Do. in course of publication on the Scale of 2 Miles = 1 Inch.
Triangulation Chart Degree Sheets are numbered thus.
Sheet No. 78 has also been published on the Scale of 1 Mile = 1 Inch.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Published under the direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India, at the Surveyor General's Office, Calcutta, October 1881.

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Major General J. T. Walker, C.B., R.A., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, October 1870.

of Solon and Dagshai will be continued on the scale of 24 inches = 1 mile.*

X.—THE MYSORE SURVEY (No. 8 TOPOGRAPHICAL PARTY).

51. The area of triangulation in the province of Mysore previously prepared by this party was so large as to render it unnecessary to make any farther extension of it during the season under review, the whole strength of the party was, therefore, employed on the topographical delineation of the Mysore-Kanara frontier with a view to having the maps of that rugged and difficult country ready for the use of the Boundary Commission in the ensuing season.

Personnel.

Captain G. Strahan, Deputy Superintendent, in charge.
Captain J. R. McCullagh, R.E., Assistant Superintendent.
Mr. R. W. Chew, Surveyor 2nd grade.
„ L. Pocock, „ 4th „
„ A. James, Assistant Surveyor 1st grade.
„ C. Tapsell, „ „ 1st „
„ F. Kitchen, „ „ 1st „
„ W. Stotesbury, „ „ 1st „
„ H. Todd, „ „ 1st „
„ G. Flemming, „ „ 4th „
„ J. Kennedy, „ „ 4th „
Sub-Surveyor Ragavayangar,
„ Tiruvenkatasami,
and three others.

52. The programme had been so arranged, that, no unforeseen circumstances intervening, the whole of this frontier would be surveyed in detail. Unfortunately, owing to sickness and the exceeding difficulty of surveying in such country as the Malnád of Mysore, this plan became impossible, and two small gaps aggregating about 25 miles in length have been unavoidably left in the frontier survey. It is hoped that arrangements may be made early in the season to supply the Boundary Commission with some sort of a map of these missing parts, so as not unduly to extend the time they will employ on this settlement work. The total outturn of detailed topographical survey during the season was as follows:—

	Square miles.	
In the Malnád forests . . .	1,911	
In the vicinity of Bangalore . .	188	
Total .	2,099	All on the scale of 1 mile = 1 inch.

53. A large part of this area was examined in the field according to departmental practice by competent officers and was found accurate. During the progress of this topography, many of the Ghât roads, whose courses are very intricate, were surveyed independently by theodolite and chain; 251 linear miles, entailing 4,410 theodolite stations, were thus measured.

54. The survey operations during the season under review were carried on under great and numerous difficulties, the ruggedness of the Western Ghâts combined with the tangled luxuriance of the forest, the absence of communications, difficulties of obtaining supplies and apathy of native officials, all conspired to retard progress, as well as the repeated attacks of fever to which many members of the party were exposed.†

55. The ordinary methods of working with the plane-table were in many places utterly impracticable, and resort was had to special methods, particularly that known in the department as plane-table traversing, in which the plane-table supplies the place of an angular instrument, and the measurements are made by chain. This is at all times slow; but where the chain lines have, as in this case, to be cleared through dense forest, the progress of the work becomes small indeed. All the mapping of the country surveyed during the field season was incorporated in the fair sheets drawn during the recess, and those which were complete, *viz.*, sheets 18, 22, 50 and 63, are now in course of publication; the remainder, *viz.*, standard sheets 20, 21, 25, 26 and 49, have been retained in the office of the party at Mysore for completion during the ensuing season.

* Colonel Depree reports favourably of all the members of his party, and specially mentions Mr. McGill, the senior Surveyor.

† The Deputy Superintendent is happy to be able to report very favourably on the assistance rendered, both in field work and recess, by the Assistant Superintendent, Captain McCullagh, R.E., whose previous experience in the Malnád proved very valuable in forestalling some of the difficulties to be met with in that district.

The services of the undermentioned Surveyors and Assistant Surveyors also deserve prominent mention:
Messrs. Chew, Pocock, Kitchen, Stotesbury and Flemming.

The two undermentioned Assistants, *viz.*, Messrs. James and Todd, were much incapacitated by illness, or they would doubtless have been entitled to equal credit with the others.

56. The present state of the work of this party is as follows:—

	Square miles
Area surveyed up to the end of last field season	9,316
Area remaining for survey, about	18,000
„ triangulated in advance of detail survey	16,900

XI.—THE GUZERAT TOPOGRAPHICAL SURVEY.

57. Three descriptions of work are being carried on by this survey, as follows:—

Personnel.

Lieutenant-Colonel C. T. Haig, R.E., Deputy Superintendent, officiating 1st grade.
Mr. T. A. LeMesurier, Assistant Superintendent, Guzerat Revenue Survey.
„ A. D'Souza, Surveyor 1st grade.
„ A. D. L. Christie, Surveyor 4th grade.
„ C. H. McA'Fee, „ 4th „
„ J. Bond, Assistant „ 1st „
„ S. F. Norman, „ 4th „
„ C. A. Norman, „ 4th „
„ R. F. Warwick, „ 4th „
„ A. George, „ 4th „
Gopal Vishnu, Sub-Surveyor.
Lakshuman Gharparé, Sub-Surveyor.
Bhau Govind, „
and 18 Native Sub-Surveyors and Apprentices.

1*st*.—The ordinary topographical survey executed on the 2-inch scale, but published on the 1-inch scale:

2*nd*.—The publication of a series of maps on the 2-inch scale comprising British territory in detail and foreign in skeleton: and

3*rd*.—The survey of the Dangs forests on the 4-inch scale.

58. The ordinary topographical work was carried on over an area of 1,052 square miles, sub-divided between British and Foreign territory as under—

		Square miles.
British	Ahmedabad Collectorate	43
	Broach „	52½
	Surat „	332½
Foreign	Baroda Territory	369
	Mahi Kanta States	176
	Rewa Kanta States	72½
	Sachim States	6½

and situated in four "sheets" (½ a degree longitude by ¼ degree latitude), of which only two can be immediately published (as the third and fourth are not yet complete), and of these the British territory will be published in three maps on the 2-inch scale.

59. An area of 110 square miles in the Dangs forests has been surveyed on the 4-inch scale, admitting of the addition of four more maps to the series of that survey which join on to the south of the area previously surveyed, completing a very compact block of this wild, hilly country.

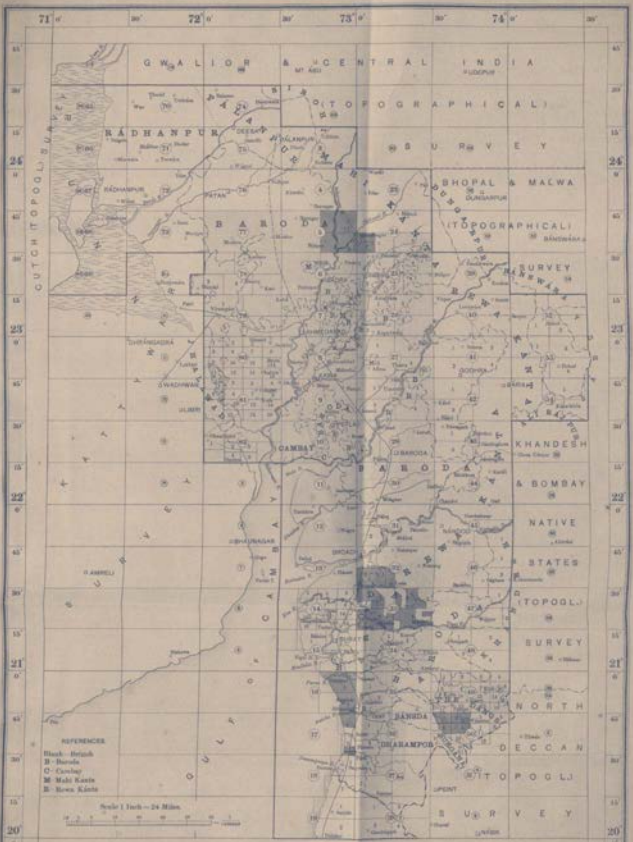
60. The operations of the past season bring the total area topographically surveyed in Guzerat up to about 12,060 square miles, and leave about 18,340 square miles to be done hereafter. In the Dangs about 300 square miles have been completed, and about 550 square miles remain.

61. The outturn of topography on the 2-inch scale has been less by 151 square miles, and that on the 4-inch scale by about 35 square miles, than in the preceding year. This is owing partly to the party taking the field somewhat later than usual on account of the unusual amount of mapping on hand at the close of the recess as mentioned in paragraph 70, page 14, of last year's report, partly to many casualties caused by sickness, but chiefly to the very intricate nature of the ground surveyed.

62. A large area has been triangulated in advance for future topography, that executed during the past season having been carried chiefly over the British territory in the southern portion of the province. An area of 750 square miles is now ready for final survey in the north of the province, and about 2,400 square miles in the southern portion, including about 650 square miles in the Dangs, and the traversing connecting the work of the Guzerat Revenue Survey with the triangulation has been carried over the whole of the British territory in Guzerat, with the exception of a small area of about 60 square miles at the extreme south of the Surat Collectorate, and also with the exception of the Panch Mahals, which have been surveyed more recently by the Guzerat Revenue Survey on a principle different from the rest of the province, which

SURVEY OF INDIA.

INDEX CHART of the GUZERAT SURVEY.

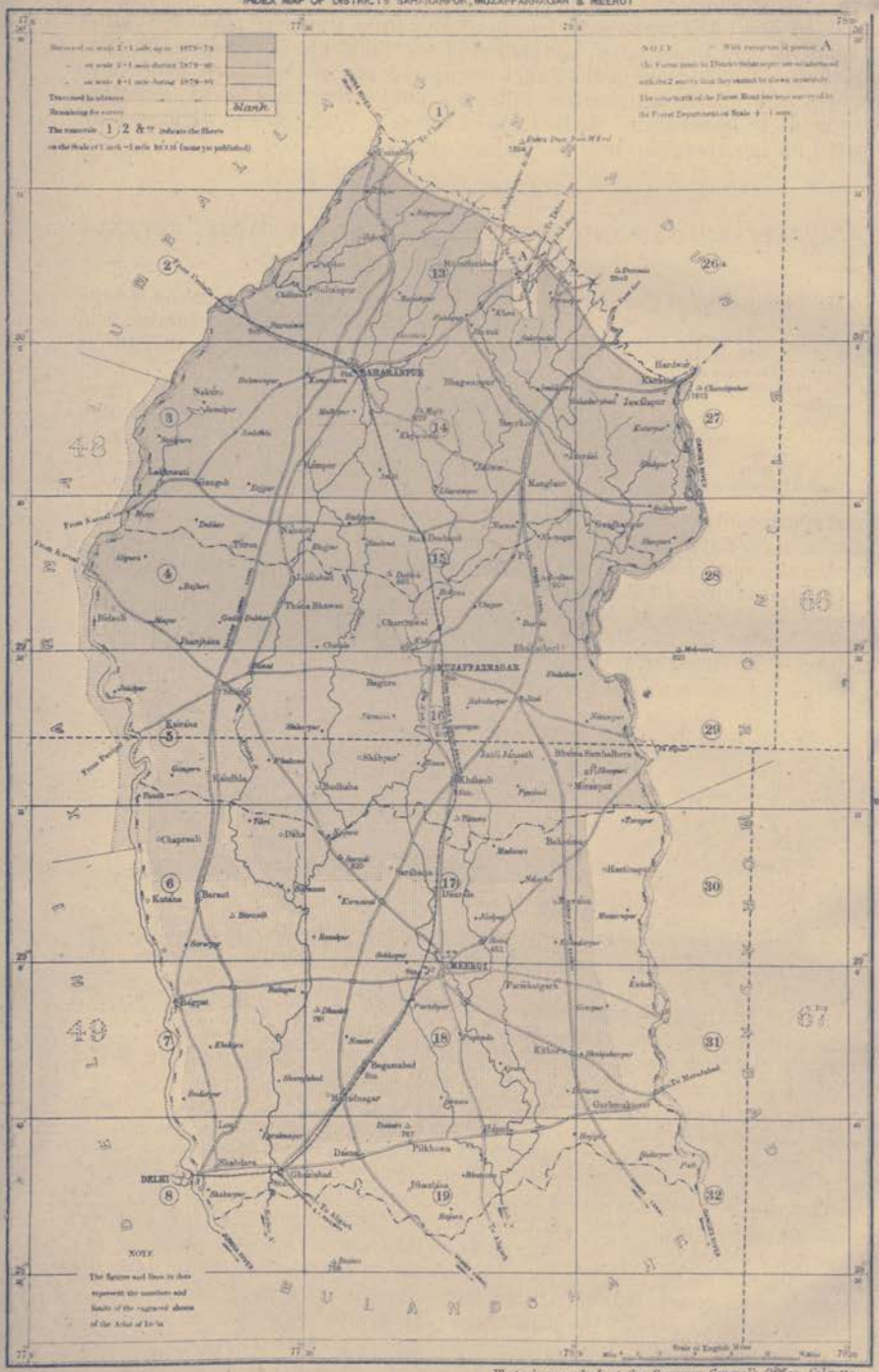


The numerals (3) (4) &c. indicate the sheets of the Survey on the scale of 1 inch to the mile.
The small numerals thus 1·1· indicate the sheets of adjoining surveys.
The originals of the 3 inch sheets are drawn on four-inch mural and zenithal arc theodolites, known as N. E., S. W., S. E. and S. W.
Registered numbers in sheets 19, 23, 25, 26, 27 and 28 indicate plane-tabling on a scale of 4 inches to the mile.
Note 2. — In other sheets outlines in black mark graduations of Jungle Survey.

Photo-zincographed at the Office of the Superintendent, Survey of India, Dehra Dún, November 1880.

N.W. PROVINCES SURVEY

INDEX MAP OF DISTRICTS SAHARANPUR, MUZAFFARNAGAR & MEERUT



Photozincographed at the Surveyor Generals Office, Calcutta.

Published under the direction of Major-General J.T.Walker. C.B.;R.E.;F.R.S., *Surveyor General of India.*

Surveyor Generals Office, Calcutta, November

1880

will render the work of the Revenue Surveyors much more easy of incorporation with that of this department.

63. The area triangulated in advance for future topography was 844 square miles, in which 504 stations and points were fixed, 80 having their heights determined also; the aggregate length of the lines traversed was 795 miles as a basis for the topography, and 590 of check lines on the topography after completion. Ten sections of the 2-inch maps, and one of the 4-inch maps have been sent in to the Head-Quarters office for publication, and eight more are nearly ready to be sent in. Reductions of sheets 6, 7, 28, 29 and 31 have been prepared for incorporation into the Indian Atlas.*

XII.—MUZAFFARNAGAR AND MEERUT SURVEY (No. 3 PARTY, REVENUE BRANCH).

64. This party, of the strength noted in the margin, and under the charge of Major W. H. Wilkins, resumed field operations in the Muzaffarnagar District on the 18th October.

Personnel.
Major W. H. Wilkins, Deputy Superintendent 3rd grade, in charge.
Mr. E. C. Ryall, Officiating Assistant Superintendent 2nd grade.
„ J. Todd, Surveyor 3rd grade.
„ R. C. D. Ewing, Assistant Surveyor 1st grade.
„ C. W. Wilson, „ „ 2nd „
„ C. W. F. Seyers, „ „ 2nd „
and 34 Sub-Surveyors, &c.

65. The regular work of the party is the topographical survey, on the 2-inch scale, of the districts in the North-Western Provinces lying between the Ganges and the Jumna, and this survey has been continued southwards from the work of the previous season as far as the parallel of Latitude N. 29° 08′; but in addition to the 2-inch survey, the party has also extended the special 4-inch survey, described in paragraph 80 of last report, of the villages subject to fluvial action on both banks of the Jumna, and has advanced southwards, as far as the river forms the common boundary of District Karnal of the Punjab with District Meerut of the North-Western Provinces. The areas of the two descriptions of survey are as follows:—

Districts.	Scale of survey.	Area surveyed in square miles.	Remarks.
Muzaffarnagar . . .	2″ = 1 mile	1,139·99	
	4″ „	53·50	Mauzawar.
Meerut	2″ „	381·21	
	4″ „	23·59	Do.
Karnal	4″ „	80·00	Do.
Total .	.....	1,678·29	

The survey of District Muzaffarnagar has been completed during the season. In addition to the area of which the topography has been surveyed in the Meerut District, the preliminary traverse work has also been done of 1,256 square miles in readiness for topographical survey during next season.

66. Regarding the nature of the 2-inch topographical survey, Major Wilkins reports:—

"The survey has been as minute as the scale would allow. All cart tracks and roads, masonry wells, topes of trees, temples and other prominent objects, as well as village sites, are shown. Limits of jungle and grass lands, except unimportant patches, have been surveyed. Great attention has been given to all drainage lines, and low ground has been carefully defined."

The village boundaries have been introduced on the final 2-inch maps, as in former seasons, by transfer from the settlement field maps, with the exception of the villages in the alluvial lands of the Ganges, where some of the boundaries had to be obtained by actual survey, a reliable connection with the settlement survey not being possible on account of the want of trijunction platforms in those lands; the field maps of the low-lying villages were also not so good as in the uplands.

* Messrs. D'Souza, McA'Fee, Christie, Bond and Norman have each done good work as usual. Of the native plane-tablers, Gopal Vishnu and Bhan Govind are stated by Colonel Haig to be prominently at the top of the list.

67. The success of the system of transferring the village boundaries from the settlement field maps to the survey maps entirely depends on the accurate identification of the points adopted as trijunctions of village boundaries by the settlement survey. Most of these points in the Saharanpur and Muzaffarnagar Districts had originally been marked by low platforms, and in those Districts these marks were repaired, or newly constructed, prior to survey, so that in Saharanpur and Muzaffarnagar the identification of the trijunction points has been satisfactory. The repair of these platforms has given a permanent value to the traverses of the topographical survey; and should it ever be required to repeat the settlement survey, skeleton plots of the trijunctions could be furnished which would form the basis of a new set of settlement maps. It is to be regretted that the repair or construction of these platforms is not being carried out in the Meerut District; the Government of the North-Western Provinces have refused to sanction the necessary expenditure, on the grounds that the survey operations are regarded as being purely topographical, the present necessity of restoring the platforms as boundary marks, or the prospective advantage of obtaining a skeleton basis for a settlement survey, not being recognised.

68. The 4-inch survey of the villages on the Jumna has been carried out as explained in paragraph 80 of last report, to obtain accurate maps of the boundaries of villages, regarding which there had hitherto been much uncertainty, as well as to obtain a true definition of the District boundaries on the river, which also forms a part of the boundary between the North-West Provinces and the Punjab. The survey has been extended as far as the southern limit of the Karnal District; and the boundaries have been surveyed as pointed out by the people, without previous demarcation by the civil authorities. The disputed boundaries between Districts Ambala and Saharanpur, which had come to notice during the previous season, have been settled by representatives deputed by the respective Governments of the North-West and Punjab, with whom a surveyor was associated as a referee on the matter of old boundary lines, and to provide for the immediate survey of the adjusted boundaries. Regarding the adjustment of the disputed boundaries, Major Wilkins reports:—

"In nearly every case arbitration by a *panchayet* was adopted, this being approved by the people themselves. The advice of Mr. Todd (the Surveyor) was eagerly sought for by the people regarding their boundaries; and the presence of an European Surveyor undoubtedly enabled the disputes to be settled, and without him no decision could have been come to. The zemindars told Mr. Todd *plainly* that they were agreeable to whatever boundaries he laid down; but he informed them that it was impossible in most cases to lay them down accurately, as the *thakbusts* were worthless, and for this reason arbitration had to be employed."

Regarding the *thakbust* maps of the river villages, Major Wilkins further reports:—

"They are so distorted in shape that they cannot be depended on for laying down any boundary."

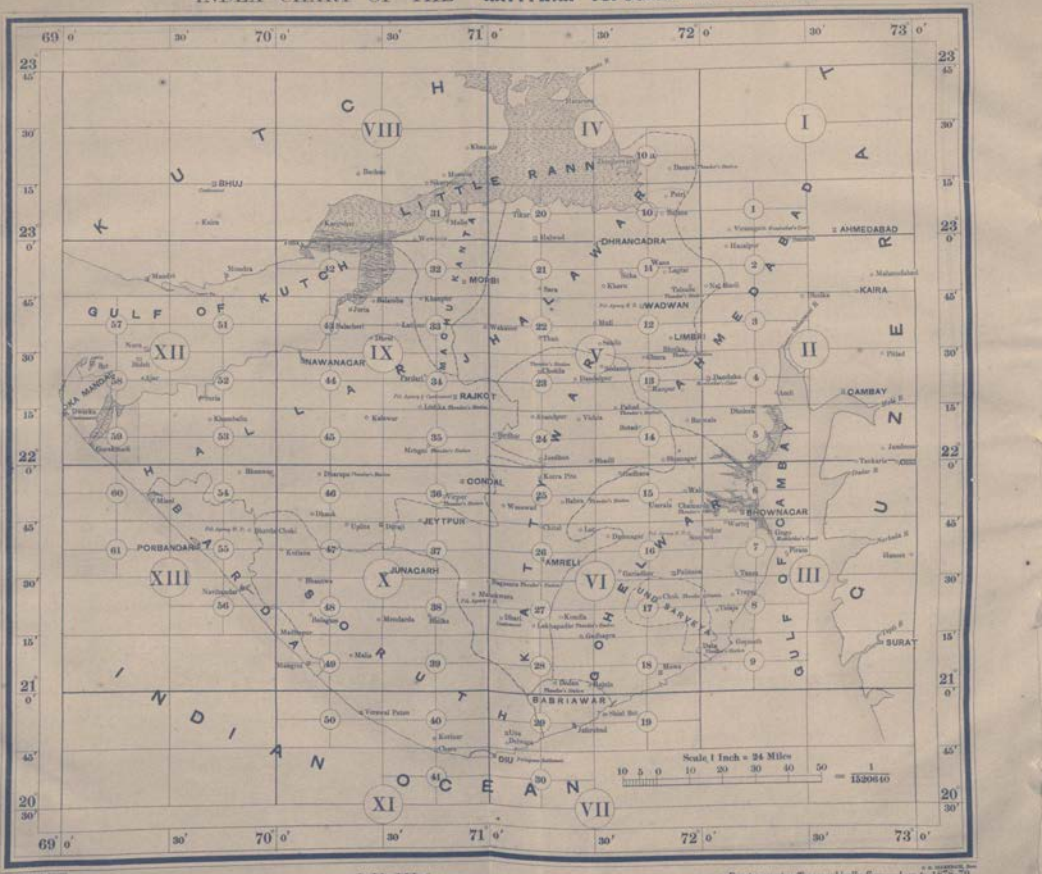
The disputes on the boundary between Karnal and the Districts of the North-Western Provinces are not so numerous as those which were found on the Ambala boundary; and it is hoped the Provincial Governments may consent to the deputation of Civil Officers to settle these disputes, the same as was done for those of Ambala last year.

69. During the season's operations, four principal stations of the Great Trigonometrical Survey have been connected with the *measured* traverses, and their co-ordinate values have been used to correct the errors of the chaining, in which the average error was found to be 2 links per 100 chains, or about 1 foot per mile. Check lines aggregating 274 miles in length have been measured through the topographical board plans by Major Wilkins and his assistants; and observations for azimuth to check the angular work of the traverses have been taken at 69 stations.

70. The mapping is still somewhat in arrears, the sheets having only been completed southwards to the parallel of 29° 30'. The drawing of the Sewalik Hills in the Saharanpur District by transfer from the Forest Survey maps has however, been completed; and in all, 43 standard sheets for reproduction on the 2-inch scale, and 47 "exaggerated" copies for reduction to the 1-inch scale are now ready.

GREAT TRIGONOMETRICAL SURVEY OF INDIA.

INDEX CHART OF THE **KATTYWAR TOPOGRAPHICAL SURVEY.**



C. F. OTTAWAY, PHOTO.

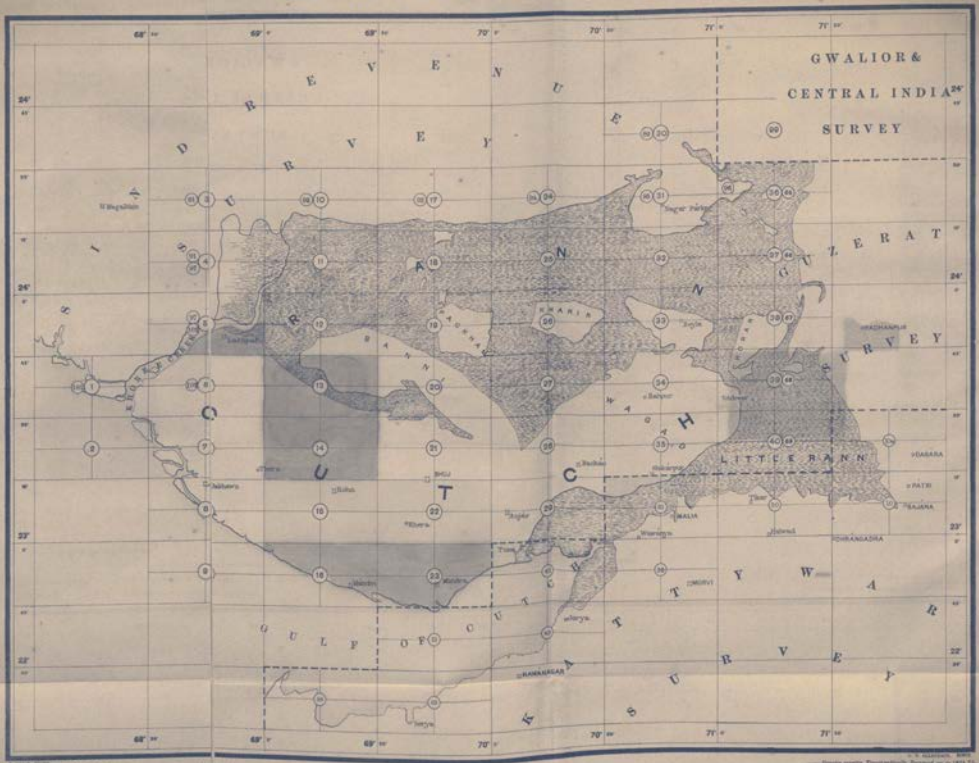
The numerals 1, 2, 3 &c., indicate the sheets on the scale of one inch to the mile. The numerals I, II, III &c., indicate the degree sheets, on the Scale of ¼ inch to the mile. The one inch sheets are divided into 4 sections known as the **N. E., N. W., S. E., & S. W.**, sections of the sheet, of these a few copies will be published on the Scale of the original Survey, etc., 8 inches to the mile for the use of local officials.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1881.

— *Denotes country Topographically Surveyed up to* 1878-79.
" " " " *in* 1879-80.
" " ~~*Triangulated in advance.*~~

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.


GWALIOR & CENTRAL INDIA SURVEY
GUJERAT SURVEY
KATHIAWAR SURVEY
GREAT RANN
LITTLE RANN
CUTCH
GULF OF CUTCH
KHARIA
NANA
MOTA
BANNI
WAGAD
Bhachau
Anjar
Bhuj
Mundra
Mandvi
Lakhpat
Nakhatrana
Rapar
Adesar
Wagad
Chobari
Dhrangadra
Halvad
Wadhwan
Morvi
Malia
Wankaner
Rajkot
Jamnagar
Kanakrasar
Hadiana
Patri
Rajana
Dhrangadra
Viramgam
Sanand
Dholka
Dhandhuka
Gogha
Bhavnagar
Sihor
Mahuva
Talaja
Kodinar
Una
Diu
Veraval
Porbandar
Jodiya
Jam Khambalia
Dwarka
Okhamandal
Salaya
Jam Jodhpur
Kalyanpur
Khambhalia
Jam Kandorna
Jam Jodiya
Jam Rawal
Jam Ranmal
Jam Ranjitsinhji
Jam Vibhaji
Jam Digvijaysinhji
Jam Sataji
Jam Ranmalji

71. The office of the party was inspected at Mussoorie during October; the records were found to be in order, and the office duties were being carried on systematically.*

XIII.—THE SURVEY OF KATTYWAR (KATHIAWAR) AND CUTCH.

72. At the commencement of the field season the topography of the district of Okhamandal, which is situated at the western corner of the peninsula, remained for execution in Kattywar; this has now been completed, and with it the general survey of Kattywar. In a few places the boundary lines between the talooks appertaining to the several Native States have not been surveyed, and are still shown in the maps as "approximate," because they were disputed and had not been demarcated when the survey was being made. Major Pullan thinks that the survey of the province may now be considered finished, and that it is not worth while going to the expense of sending a traverse party to pick up the few scattered breaks which remain for survey to complete these boundaries; and if the Political authorities, to whom this question has been referred, are of the same opinion, nothing more will be done.

Personnel.

Major A. Pullan, S.C., Deputy Superintendent 3rd grade.
Mr. N. C. Gwynne, Surveyor 4th grade.
„ W. A. Fielding, Assistant Surveyor 2nd grade.
„ G. T. Hall, „ „ 3rd „
„ P. F. Prunty, „ „ 4th „
„ J. Keating, „ „ 4th „
Visaji Raghunath Godboli, Head Sub-Surveyor, and 11 other Sub-Surveyors.

73. The area finally surveyed on the 2-inch scale for reduction to the 1-inch scale amounted to 2,133 square miles, of which 494 were in Kattywar and 1,639 in the sister province of Cutch; the average number of plane-table stations was 12·6 per square mile of topography. The triangulation in advance covered an area of 1,150 square miles, fixing 56 stations and 462 points and giving the heights of 119 points. Of traversing, 1,224 linear miles were executed, and test lines of an aggregate length of 296 miles were carried over the topography.

74. During the recess season fair maps of sheets 57, 58, 58*a*, 59, and 59*a* of Kattywar, and 15 and 22 of Cutch, each in four large sections on the 2-inch scale, were completed and sent to the Head-Quarters office for publication. The whole of the current computations were duly brought up. Twelve of the standard sheets were reduced from the 1-inch to the $\frac{1}{4}$-inch scale for incorporation in the engraved Indian Atlas. Two of the general reports for square degrees, Nos. v and vi, have been completed and sent in, and a third, No. ix, was nearly ready.†

XIV.—AHMEDNAGAR, POONA, AND COLABA SURVEY (No. 10 PARTY, REVENUE BRANCH).

75. This party, of the strength noted in the margin, took the field in two sections and resumed field operations on 15th November. One section has been engaged in completing the survey of the portion of the Deccan which had been allotted to this party for survey, with which also has been included the survey of the Ashti Taluka of the Nizam's Dominions, as it is surrounded by Deccan country. The second section has commenced the topographical survey of the Konkan, where preliminary triangulation had been done last season. The 2-inch scale of the Deccan surveys has been continued in the survey of the Konkan,

Personnel.

Colonel J. Macdonald, Deputy Superintendent 2nd grade, in charge.
Mr. G. H. Cooke, Assistant Superintendent, Officiating 2nd grade, on furlough for 1 year, from 22nd May 1880.
„ A. M. Lawson, Surveyor, 3rd grade.
„ J. Newland, Assistant Surveyor, 1st grade.
„ W. M. Kelly, „ „ 3rd grade, transferred from No. 5 Party, 11th November 1879.
„ R. R. Dickinson, Assistant Surveyor, 3rd grade.
„ H. Corkery, Assistant Surveyor, 4th grade, proceeded to Afghanistan on field service, 18th October 1879;
and 18 Sub-Surveyors, &c.

* Major Wilkins has reported on his Assistants as follows:—

Mr. E. C. Tyrall has done very well in the field.
Messrs. Todd, Ewing and Wilson have given uniform satisfaction both in field and office.
Mr. Seyers has done well in office, but some of his field work was indifferent.

The following Sub-Surveyors and others of the Native Establishment are selected for favourable mention: *viz.*, Nundlall Chatterjee, Kedar Nath, Bhugobutty Chuckurbutty, Surfaraz Khan, Mahomed Zakaria, Hidayatulla, Boithram, Allahad Khan, Sharaf din, and Ali Hosan.

† Major Pullan reports favourably of all his European Assistants, and commends Sub-Surveyors V. R. Godboli, Narsu Dinkar, K. Govind, Ganesh Ramchundra, K. Vital, and Tukaram Chowdry.

but the village boundaries have been obtained by direct survey, as it was found that the transfer of the boundaries in such hilly country from the Bombay Revenue Survey maps would not be satisfactory. A comparison, however, has afterwards been made in office between the boundaries according to the two surveys.

76. The area surveyed topographically in the Deccan is 1,150 square miles, and in the Konkan 845 square miles. The total area of 1,995 square miles is less than the outturn of the previous year by 220 square miles, but the decrease is stated by Colonel Macdonald to be due to the nature of the work in the Konkan, where the country itself is very intricate, being hilly and largely covered with jungle, and where also the smaller villages necessitated a great increase in the boundary traversing beyond what had hitherto been required in the Deccan. Colonel Macdonald anticipates that there will be a still further reduction in the out-turn when the work is entirely confined to the Konkan.

77. The preliminary triangulation for future work in the Konkan has been extended over an additional area of 2,520 square miles; and the boundary traversing in advance has been completed of 475 square miles. The triangulation is comprised within 71 secondary triangles and 271 tertiary triangles, besides which there are 124 points fixed by intersections. In these triangles, the average differences found on comparison of common sides are, 4·87 inches per mile for the secondaries, 6·29 inches for the tertiaries, and 12·1 inches for the intersected points. The heights of 126 points have been determined by means of vertical angles; these determinations of height have been verified by independent observations to the same points, resulting in an average difference of 3·72 feet. Mr. G. H. Cooke, Assistant Superintendent, who carried on the triangulation, experienced the same difficulties as last season from the hazy state of the atmosphere, and his progress was also much hindered by the attacks of guineaworm amongst the signallers, not one of whom is said to have been free from the malady. Check surveys aggregating 323 linear miles were measured in the open parts of the country; in hilly parts, the work of the topographers was checked *in situ*. Colonel Macdonald himself visited and inspected every Surveyor's section.

78. The geographical limits of 4 sheets of the Deccan series of standard maps, extending over detached portions of Deccan Districts, embrace a considerable area included within the old topographical survey of the Nizam's Dominions; these sheets have been filled up to margin by transferring the details from the old maps. An area of 1,260 square miles has thus been added to the mapping of the season, and the total area which has been drawn is 3,255 square miles. In Colonel Macdonald's office, a "Reduction" to the scale of the Atlas of India has also been drawn, covering an area of 7,650 square miles of present and past seasons' work, to be used as a guide to the engravers of the Atlas, but this map is still somewhat incomplete.

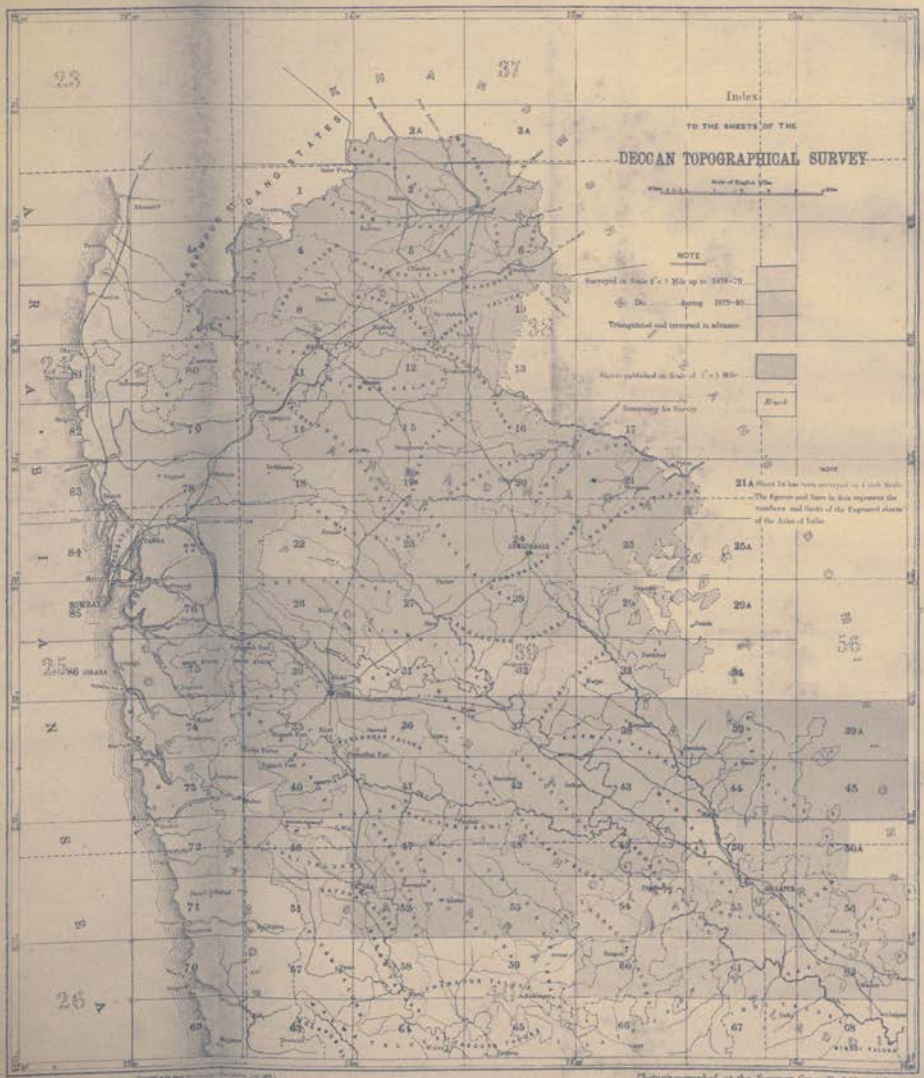
79. During the coming season, the triangulation will be extended northwards to Latitude 20°, which is the limit of the area allotted for survey to this party. The topographical survey will be confined within sheets 75, 77, 78, 79, 83 and 84.

80. The office of the party was inspected at Poona in July. The field sections were found to have been surveyed with care, and the final maps were being drawn in good taste.

A descriptive report of part of the country surveyed, submitted by Colonel Macdonald, is given in the Appendix.*

* Colonel Macdonald reports most favourably on the good services of Mr. G. H. Cooke, Assistant Superintendent, and of Messrs. Lawson and Newland. Mr. Dickinson is praised for his faithful hill-sketching; and amongst the Native establishment, who were reported to have all worked well, special mention is made of Lingoji Potana, Govind-Janardhan, Fyzulah Khan, Nathu Lall, Inayatullah Khan, and Ramrao Yadho.

DECCAN TOPOGRAPHICAL SURVEY



Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B.-R.E.-F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, November

1880

XV.—SHOLAPUR AND RATNAGIRI SURVEY (No. 11 PARTY, REVENUE BRANCH).

81. This party left recess quarters at Poona on the 10th November 1879, and proceeded by rail to Sholapur, in the neighbourhood of which town field operations were immediately resumed. Field work was continued up to 6th May 1880. Major Hutchinson held charge of the party during the whole of the field season, but for three months of the recess, while Major Hutchinson was absent on privilege leave, Mr. J. McGill held charge. The topographical outturn is 2,028 square miles, part of which area had to be triangulated, as well as surveyed in detail; and the area of preliminary triangulation and traversing done in advance for next season is 1,584 square miles. The completed area is included in sheets 50, 50A, 55 and 56; and the western portion of sheet No. 46, which had been done in 1876-77 up to the limits of the Deccan, has now been completed taking in a portion of the Konkan. The system of survey has been the same as before, and the 2-inch scale has been continued. Village boundaries, however, have been obtained by direct survey, and not by transfer from the Bombay Revenue Survey maps, as in former years. The survey of the city of Sholapur, on the scale of 80 inches = 1 mile, at the expense of the Municipality has been commenced, and about one-third is completed. The map on the 80-inch scale will be in several sections, but a general map of the city, having the cantonment added to it, on the scale of 8 inches = 1 mile, is also being prepared.

Personnel.

Mr. J. McGill, Officiating Assistant Superintendent 1st grade, held temporary charge of the Party from 16th July to 13th October 1880.
Major H. S. Hutchinson, Officiating Assistant Superintendent 1st grade, in charge, proceeded on 3 months' privilege leave on 16th July 1880, re-joined 14th October 1880.
Mr. S. M. Smylie, Surveyor 3rd grade.
„ J. T. U. Coxen, Assistant Surveyor 2nd grade, proceeded to Afghanistan on field service on 22nd October 1879.
„ J. Hickie, Assistant Surveyor 2nd grade, transferred from late 2nd Division from 1st November 1879.
„ G. C. Swiney, Assistant Surveyor, 2nd grade.
„ W. H. Penrose, „ „ 2nd „
„ G. A Knight, „ „ 3rd „
and 21 Sub-Surveyors, &c.

82. The final mapping of sheets Nos. 46, 50, 50A, 54, 55 and 56 has been completed on the 2-inch scale suitable for reduction by photography to the 1-inch scale for publication on sheets of the standard size. Sheet No. 50A, of which a portion only has been surveyed, has been drawn up to marginal limits by transfer from the maps of the old topographical survey of the Nizam's dominions. In addition to the ordinary computations of the season, the heights of all the previously published sheets have been revised in accordance with the results of the recent operations of the Bombay Tidal and Leveling Party. The drawing has been completed of the sections of the survey of Satara City, scale 80 inches = 1 mile, executed during the previous year; and the sections, 23 in number, have been published at the Government Photographic Press at Poona. A general map of the city and cantonment of Satara on the scale of 8 inches = 1 mile has also been published.

83. The triangulation is subordinate to several of the triangles of the Bombay Longitudinal Series of the Great Trigonometrical Survey, and a comparison has been made between the direct distances of two Trigonometrical Survey Stations and the computed distances by minor triangulation, showing that the average error of the latter is 2·9 inches per mile. Check surveys have been measured to the total extent of 181 linear miles, whereby the work of each of the topographers has been carefully tested; the result in most cases was very satisfactory. Sheet No. 46, as it includes a very difficult hilly country, was examined on the ground by Major Hutchinson personally.

84. During the ensuing season, the topographical survey will be continued into sheets Nos. 60, 61, 62, 67 and 68, sheets Nos. 60 and 61 having been already triangulated, and the village boundaries partially traversed.

85. The recess office of the party was inspected at Poona in July. Good progress had been made with the final maps, and the drawing was being done carefully.*

* Both Mr. McGill and Major Hutchinson report favourably of all the assistants; Messrs Smylie, Hickie, Swiney and Knight being specially commended by Mr. McGill. Of the native establishment, Toolsee Ram, Amant Narain, Malloo Sayee, and Chandoo Meean are mentioned by name for their good services.

MAUZAWAR OR VILLAGE SURVEY.

XVI.—DERA ISMAIL KHAN AND RAWALPINDI DISTRICTS (No. 1 PARTY, REVENUE BRANCH).

86. The field operations of this party were resumed under the superintendence of Captain H. L. Smith, Assistant Superintendent; but in the meantime Lieutenant-Colonel D. Macdonald had been posted to the party on the breaking up of his late party, which had been employed in the Sirsa District, and he relieved Captain Smith on the 6th December 1879. The party, of which the strength is noted on the margin, took the field in two sections; one section moved out from recess quarters at Murree during October to continue their work in the Murree and Kahuta Tehsils of the Rawalpindi District; the second section marched down to the Dera Ismail Khan District, and resumed work there on 15th November. Some of the Surveyors continued at work in the Murree and Kahuta Hills until the end of May; in Dera Ismail Khan, field work was closed on 1st April.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent 2nd grade, in charge from 6th December 1879.
Captain H. L. Smith, Assistant Superintendent 1st grade (in charge from 1st October to 5th December 1879).
Mr. G. Honsden, Surveyor 1st grade, retired on pension from 1st November 1879.
„ G. B. Scott, Surveyor 3rd grade, joined from 14th June 1880.
„ W. S. Buttress, Surveyor 3rd grade.
„ A. J. Gibson, „ 4th „
„ R. Todd, Assistant „ 1st „
„ P. A. Peters „ „ 3rd „
„ J. C. Kelly, Probationary Assistant Surveyor 4th grade, and 22 sub-surveyors, &c.

87. The survey of the Murree and Kahuta Tehsils, which has been done for the Forest Department, has now been completed; and, at the request of the Conservator of Forests at Murree, the survey has been extended so as to include two small Forest Reserves in Tehsils Rawalpindi and Gujar Khan. For the Forest Department, the "Kala Chitta" Range of hills in the Rawalpindi District still remains to be surveyed, but the preliminary triangulation of the tract has nearly been finished.

The following statement shows the outturn of completed survey, during the season, both in the Rawalpindi and Dera Ismail Khan Districts:—

District.	Sub-divisions.	Scale 4" = 1 mile.
		Square miles.
Dera Ismail Khan . . .	Pargana Bhakkar	1,334·7
Rawalpindi	Tehsil Kahuta	386·4
	„ Rawalpindi	12·3
	„ Gujar Khan	11·0
Total . .	...	1,744·4

In addition to the above, the preliminary boundary traversing of 1,934·3 square miles in Pargana Bhakkar of Dera Ismail Khan has been done, besides the preliminary triangulation of 450 square miles of the Kala Chitta Range in Rawalpindi.

88. Respecting the country surveyed in Dera Ismail Khan, Colonel Macdonald reports:—

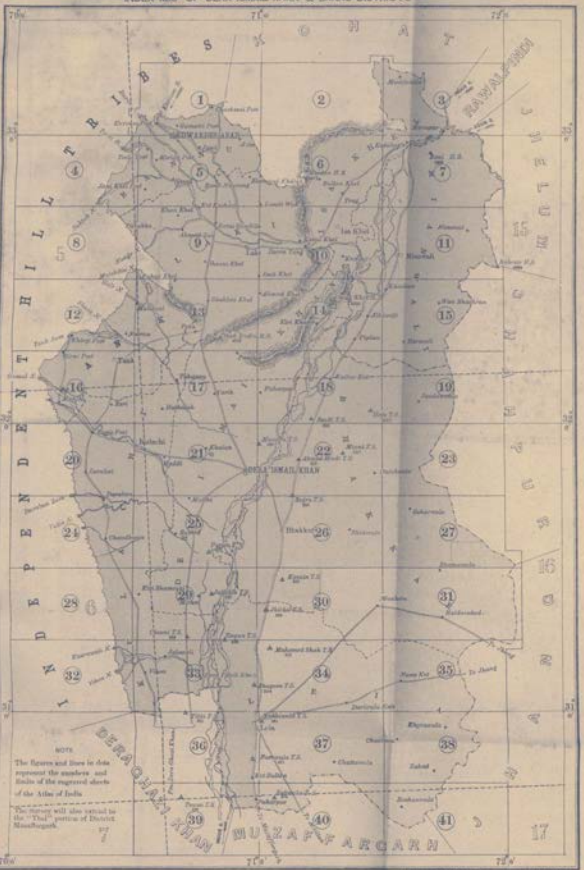
"It is a portion of what is termed the '*Thal*' (or sandy region). The country, as the name indicates, is sandy and barren, covered with sand-hills more or less permanent. Hamlets are few and far between, with a well or two surrounded by a few fields. Small tanks are scattered about over the face of the country, where flocks are occasionally watered after a rainfall. Melons are largely cultivated as might be expected from the nature of the soil."

* * * * * *

"There is no such item separately recorded on the maps as 'fit for cultivation;' the whole area almost might be included in this item, if water could be made available. The distance in feet between the surface of the ground and the surface of water in wells at the time of survey has been indicated on the maps in the usual manner."

PUNJAB SURVEY

INDEX MAP OF DERA ISMAIL KHAN & BANNU DISTRICTS


KOHAT
BANNU
HILLS
INDEPENDENT
DERA ISMAIL KHAN
MUZAFFARGARH
DERA GHAZI KHAN
NOTE.
The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India.
The Survey will also extend to the "Thal" portion of District Muzaffargarh.

Surveyed on Scale 4-1 mile up to 1878-79

during 1879-80

Triangulated and Traversed up to 1879-80.

Scale of English Miles

Photolithographed at the Surveyor General's Office Calcutta

The numerals (1) (2) &c indicate the Sheets 24 X 16 on the Scale of 1 inch = 1 mile

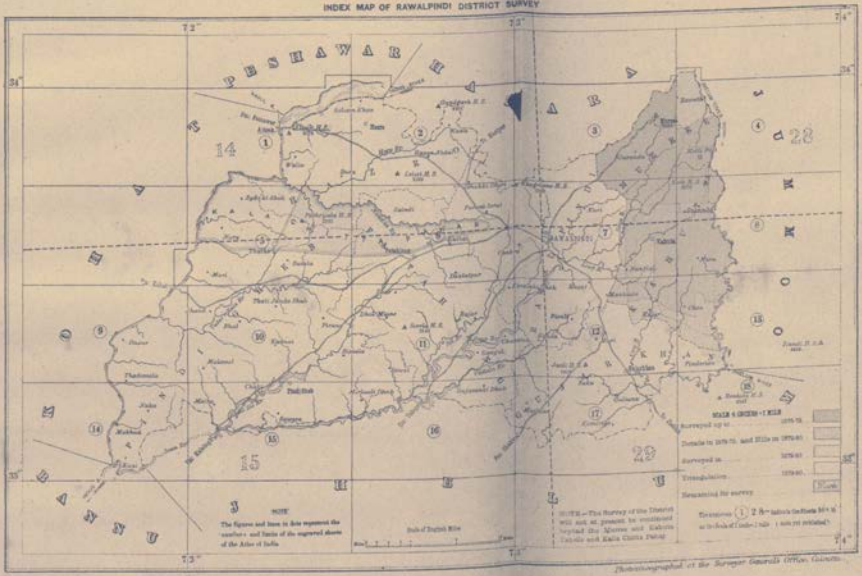
(some yet published)

Published under the direction of Major General J.T Walker, C.B. R.E. F.R.S., Surveyor General of India.

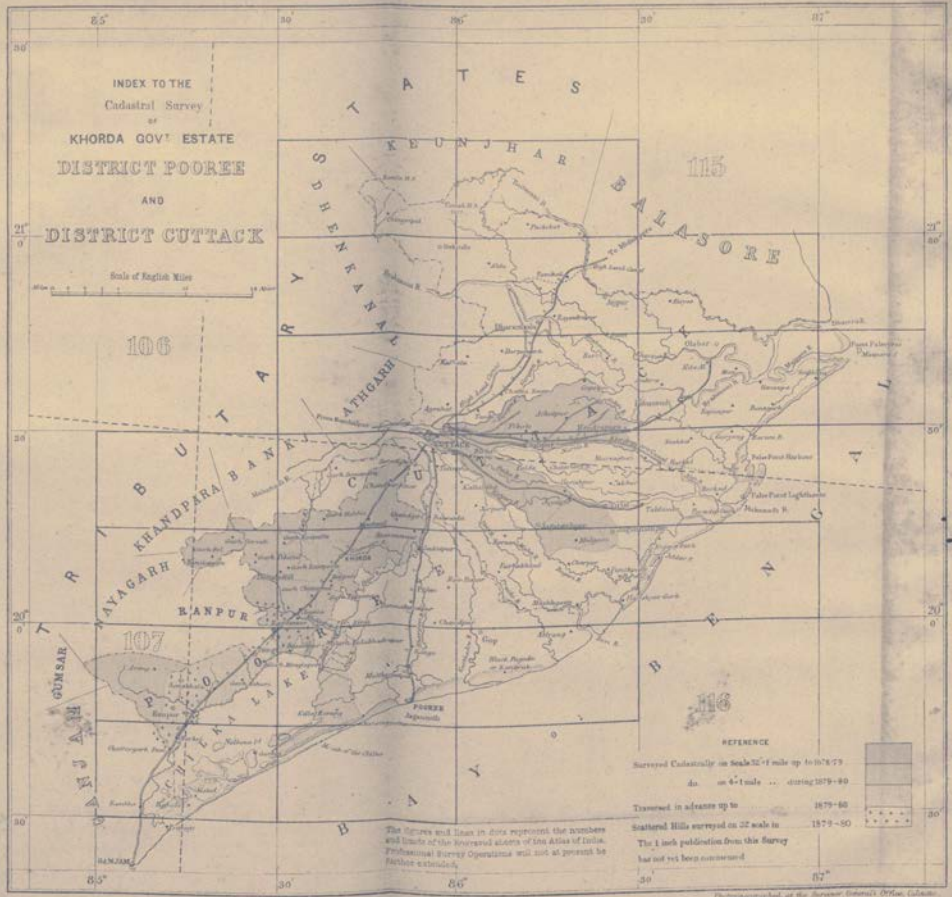
For our Generals Office, Calcutta, November 1880.

PUNJAB SURVEY

INDEX MAP OF RAWALPINDI DISTRICT SURVEY


PESHAWAR
HAZARA
MIANWALI
JHELUM
SHAHPUR
DERA GHAZI KHAN
RAWALPINDI
Attock
Campbellpur
Chakwal
Fateh Jang
Gujar Khan
Kahuta
Kallar Kahar
Kohat
Kushalgarh
Mianwali
Pabbi
Pindigheb
Talagang
Taxila
Wah
Jhelum
Sohawa
Dina
Mandra
Kamra
Fatehjang
Pindi Gheb
Mianwali
Isakhel
Piplan
Talagang
Chakwal
Choa Saidan Shah
Kallar Kahar
Kohat
Pabbi
Peshawar
Attock
Campbellpur
Wah
Taxila
Kahuta
Gujar Khan
Jhelum
Sohawa
Dina
Mandra
Kamra
Fatehjang
Pindi Gheb
Talagang
Chakwal
Choa Saidan Shah
Fateh Jang

LOWER PROVINCES SURVEY



The figures and lines in dots represent the numbers and limits of the traversed sheets of the Atlas of India. Professional Survey Operations will not at present be further extended.

Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T.Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, November 1880

The topography in Dera Ismail Khan has been tested by 85 linear miles of check surveys. As a check on the angular work of the preliminary traversing, 22 azimuths were observed showing that an average correction was required of one minute in every 16 angles. Connections were made with 6 stations of the Great Trigonometrical Survey, and the direct distances by triangulation have been used to correct the errors of the chain measurements. The average error in the chaining was found, on comparison with 6 triangulation rays, to be $\pm$·785 foot per mile. All the mapping on the 4-inch scale has been brought up to date; and copies of the maps have been prepared in the usual manner for record with the District Officer.

89. In the Rawalpindi District, the country in the Kahuta Tehsil, where the operations chiefly were carried on, is described as being very difficult to survey on a large scale, though it is less mountainous than the Murree Tehsil where the surveyors were employed last year. The number of stations of which the heights had been determined during the previous season was insufficient; and observations for height were taken last season to 250 points. There is now an average of one height to every 2 square miles in the Kahuta Tehsil, but the heights in the Murree Tehsil are still deficient and a few more observations will be taken at the commencement of next season. The final maps of these Tehsils on the 4-inch scale will be prepared on graticule sheets in size $3\frac{3}{4}'$ latitude $\times$ $7\frac{1}{2}'$ longitude, but the maps will not be completed until the boundaries of the Forest Reserves have been adjusted; and in the meantime, the Forest Department has been supplied with photozincograph copies of the field sections. These field sections are of uniform size, $3\frac{3}{4}'$ latitude $\times$ $3\frac{3}{4}'$ longitude, and each includes an area of about 15 square miles.

90. The following areas remain for survey:—

About 2,800 square miles in the Thal portion of the Dera Ismail Khan District, of which one-half will probably be surveyed next season.

The *Thal* portion of the Muzaffargarh District, in area about 1,000 square miles, to be taken up after the completion of Dera Ismail Khan.

The Kala Chitta Range in the Rawalpindi District, which contains an estimated area of 600 square miles, and of which about 450 square miles will probably be surveyed.

91. The office of the party was inspected by the Deputy Surveyor General at Murree during September. The drawing of the maps was being carefully executed and the numerical records systematically prepared. The favourable results are largely due to the close supervision which Lieutenant-Colonel Macdonald exercises over his establishment.*

XVII.—KHORDA GOVERNMENT ESTATE, DISTRICT POOREE (No. 7 PARTY, REVENUE BRANCH).

92. Mr. R. B. Smart, Deputy Superintendent 2nd grade, who had hitherto been in charge of this party, having obtained leave of absence, was relieved on the 10th October 1879 by Mr. J. Campbell, Assistant Superintendent, who has since conducted the operations. The change in procedure, referred to in paragraphs 167 to 171 of last report, has been introduced; and of the area remaining for

Personnel.

Mr. R. B. Smart, Deputy Superintendent 2nd grade, proceeded on privilege leave for 3 months from forenoon of 11th October 1879, and on furlough for 2 years from 10th January 1880.
" J. Campbell, Assistant Superintendent 1st grade, in charge from 11th October 1879.
" A. D. Smart, Surveyor 3rd grade, placed on the half pay list from 1st January 1880.
" C. David, " " retired on pension from 1st January 1880.
" W. R. Vyall, " 4th grade.
" H. Dowman, " " transferred to No. 2 party Hanthawaddy District, British Burma, from 1st November 1879.
" T. H. Dunne, Assistant Surveyor 1st grade.
" G. W. Jarbo, " " " transferred from late No. 9 party, Cuttack Irrigation Survey, from 1st April 1880.
" J. R. Scott, Assistant Surveyor 2nd grade, transferred from late No. 9 party, Cuttack Irrigation Survey, from 1st April 1880.
" G. Campbell, Assistant Surveyor, 3rd grade, transferred to No. 8 party, Bassein District Survey, British Burma, from 1st November 1879, and 16 Sub-Surveyors, &c.

Temporary Establishment.

94 draftsmen and area calculators.

* Lieutenant-Colonel Macdonald has expressed himself satisfied with the manner in which the establishments, both European and Native, have worked during the field and recess seasons.

cadastral survey, the field measurements have been left to be carried out under the orders of the Settlement Officer of Khorda. For the rest of the work, which still remained for the professional party as noted in paragraph 165, field operations were resumed on 6th January 1880, with an establishment of the strength which is given in the margin on the preceding page.

93. It was known that the chief tract for survey—the *máls* or forest lands of Banpur—was at all times unhealthy, but especially so in the early part of the cold season, and the local officers recommended that nothing should be done there until the beginning of January. Mr. Campbell reports as follows on the extreme unhealthiness of the tract:—

"Our greatest foe was the climate; without a single exception, every one who entered the *mál* jungles was sooner or later struck down with fever. Entire parties fell together on the same day, and sick men deserted by dozens at a time; the work of forming new parties and pushing them on to work was incessant."

As to other difficulties met with during his survey, Mr. Campbell further reports:—

"The Banpur máls had never before been demarcated; the people, occupying the hamlets scattered in the valleys, had hitherto escaped all taxation: they cultivated the open patches of land without let or hindrance. It is not surprising, therefore, that they looked upon the survey as an innovation, and, as far as possible, evaded giving any help. It was with extreme difficulty that coolies were got for clearing the lines, and there was constant trouble and difficulty as regards supplies."

Mr. Campbell acknowledges, in the following hearty manner, the great assistance he received from the Officiating Collector of Pooree:—

"I desire to mention the deep obligation I am under to Mr. F. F. Handley, late Officiating Collector of Pooree, for the great help he gave the survey at a very critical time. His timely visit to Banpur, and the steps he there took to ensure help being given to the survey by the headmen of villages, at once removed all anxiety about the work. But for Mr. Handley's help, the Banpur máls could not have been all surveyed this year."

Owing to the sickness among the establishment, and to the difficult nature of the country, it was found desirable in March to strengthen the party by attaching to it Messrs. Jarbo and Scott, whose work had come to an end with the Cuttack Irrigation Survey, and by transferring three Sub-Surveyors from parties in the North-Western Provinces.

94. When field operations commenced, great uncertainty existed with the Settlement Establishment as to the extent of country appertaining to the Banpur máls of the Khorda Estate, and the first line of demarcation excluded a tract of hilly country believed to belong to Goomsur of Madras. This tract has been surveyed as an overlap beyond Khorda so as to form a connection with the Madras Survey and with the Topographical Survey of the Tributary States of Orissa, but it is now stated that the tract will be incorporated with the Banpur máls of Khorda. In the meantime, the boundary of the Estate in that direction is incomplete. The area surveyed in the Banpur máls is 125 square miles, the scale of survey being 4 inches = 1 mile.

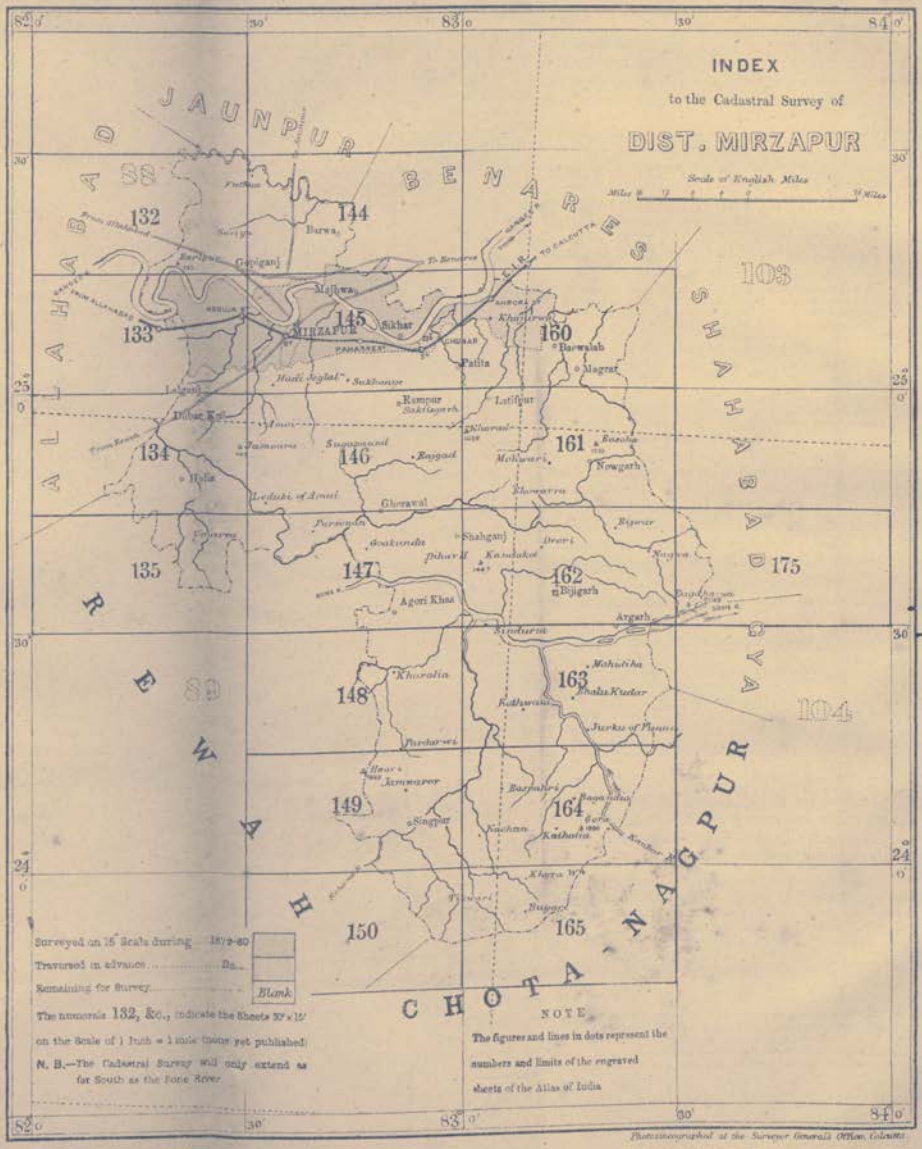
Simultaneously with the 4-inch survey of the Banpur máls, the boundary survey of the detached villages of Parganas Balbhadrapur and Tapang was carried on; and skeleton plots of the boundaries, on the 32-inch scale, have been supplied for the use of the Settlement Survey Establishment. The detached villages are 68 in number and cover an area of about 39 square miles, but a very much larger area had to be included in the traversing in order to connect the surveys of the detached villages.

The final work of the field season was the survey of the hills, in the area of which the field measurements were being carried on by the Settlement Establishment. These hills have been surveyed on the full scale of 32 inches on the original settlement sheets, instead of on the scale of 4 inches as had at first been intended. The hills are scattered over many villages and cover an area of 40 square miles.

The angular measurements were checked by 12 observations for azimuth. The topography in the Banpur máls was tested by 10 linear miles of check survey carried through the principal valleys; the Assistant Surveyors also frequently visited the topographers working in the hills and tested the surveys. The field work was completed on 30th June.

95. During the recess season, the completion of a large number of records, that have been accumulating for the past four years, has been attended to in

N.W. PROVINCES SURVEY



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Surveyor Generals Office, Calcutta, November

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addition to the regular mapping of the past season. On the 1st January 1880, 2,608 cadastral maps remained to be completed after the results of the settlement examinations had been communicated; it is expected that all these will be lodged in Calcutta by the 31st January 1881.

When the drawing is completed, the whole of the Khorda Estate will be mapped in 65 general maps on the 4-inch scale; of these, 48 containing the area surveyed by this Department are finished; the remaining 19 have been plotted in skeleton, but they will stand over until the cadastral survey now in the hands of the Settlement Establishment is completed.*

CADASTRAL or FIELD SURVEY.

XVIII.—BANDA AND MIRZAPUR DISTRICTS (NO. 5 PARTY, REVENUE BRANCH).

96. This party, of the strength noted in the margin, returned from recess quarters at Naini Tal and resumed work, partly in the Banda District, and partly in the Mirzapur District, on 1st November.

Personnel.

Colonel F. C. Anderson, Deputy Superintendent 1st grade, in charge.
Mr. E. J. Jackson, Assistant Superintendent 2nd grade, on furlough to Europe from 1st May 1880.
„ C. W. Campbell, Surveyor 1st grade.
„ E. G. Little, „ 4th „
„ R. B. Smart, Assistant Surveyor 1st grade.
„ T. F. Freeman, Ditto 2nd „ on furlough from 1st May 1880.
„ W. M. Kelly, Ditto 3rd „ transferred to No. 10 party from 1st November 1879.
„ E. P. S. Hill, Ditto 3rd „
„ P. C. H. Smart, Ditto 4th „
and 24 Sub-Surveyors, &c.

Temporary Establishment.

233 field surveyors and others.

In the Banda District, the work has chiefly consisted of the survey of the Forest Reserves on the scale of 4 inches = 1 mile. An area of 50·77 square miles was surveyed, and the total area of these Reserves, including the survey of the previous season, is now found to be 137·87 square miles. To complete the cadastral survey of the Banda District, there still remained 19·22 square miles for survey on the 16-inch scale; this area has been surveyed, and the District is now finished. In District Mirzapur, the following statement shows the extent of the completed survey :—

Names of Parganas.	No. of villages.	Area in square miles.
Kantit	775	401·73
Haveli Chunar . .	80	19·95
Total . .	805	421·68

In addition to the above, the preliminary boundary traverse survey of 117 square miles has been done in advance for next season.

97. Regarding the discontinuance of the field books of cadastral measurements, Colonel Anderson reports as follows :—

"No field sketch books have been compiled for final record. It was believed that the abolition of the field sketch book would save much time and expense both in the field and recess. In order therefore to reduce the rates, the compilation of these valuable records was done away with; but after the trial of a whole field season, I can confidently express my opinion that the saving has been effected only during the recess, and that there it is limited to the operations connected with paging and indexing. For, whether compulsory or not, the

* Mr Campbell reports of his assistants.
Mr. Vyall thoroughly understands his duties and is a deserving officer.
Mr. Dunne "rendered excellent service in the field."
Messrs Jarbo and Scott "who joined the party in April have been of great help to me."
Amongst the Native Establishment, Venket Swamy is said to stand conspicuous as an excellent Sub-Surveyor.
Joona Lall, Sumeyr Sing, Bepin Behari Bose and Ishanchunder are said to be deserving men.

experienced field surveyor, having once become familiar with the field book system, will always make his own field book in the cool of the day for personal convenience, so as to utilise the hotter hours by plotting from it on to his plane table sheets; as, therefore, the money saved by the discontinuance of the field book is insignificant, and we lose thereby a permanent record of our measurements, I hope we may be allowed to revert to the old system, in which, however, a change could easily be introduced, which would save the expense of an elaborate index."

98. Stone pillars have been placed by the Settlement authorities at the trijunctions of village boundaries, and smaller slabs at the intermediate bends in place of the usual earthen mounds. Other special marks have been fixed by the Survey Department at all the theodolite stations on the boundary, but the expense of these is recovered from the landowners, as the marks serve also as part of the boundary demarcation. Many fields were met with in villages close to the Ganges which had no ridges to define their limits, the extent of which could only be ascertained with the aid of the *putwaris*, who took measurements from certain recognised marks in other fields. After the limits of these fields had been determined, the Collector of the District, at Colonel Anderson's suggestion, tried to get the owners of the fields to demarcate the boundaries with stone slabs. The attempt to get the landowners to move in the matter was not successful; but in the villages, under the management of the Court of Wards, the field demarcation has been carried out at a very small cost.

99. For the maps of the Banda District, the boundary along the southern border touching on Foreign States was in the first instance carefully compared with the maps prepared by Mr. Spedding, who had been deputed to adjust the boundary in 1870-71. In a few instances, the boundary line was found to be wrongly interpreted by the demarcating Officer associated with the survey, owing to the very small scale (2 miles = 1 inch) of Mr. Spedding's maps; these errors were brought to the notice of Mr. McConaghey, the Collector of the District, who personally visited the boundary and rectified the errors.

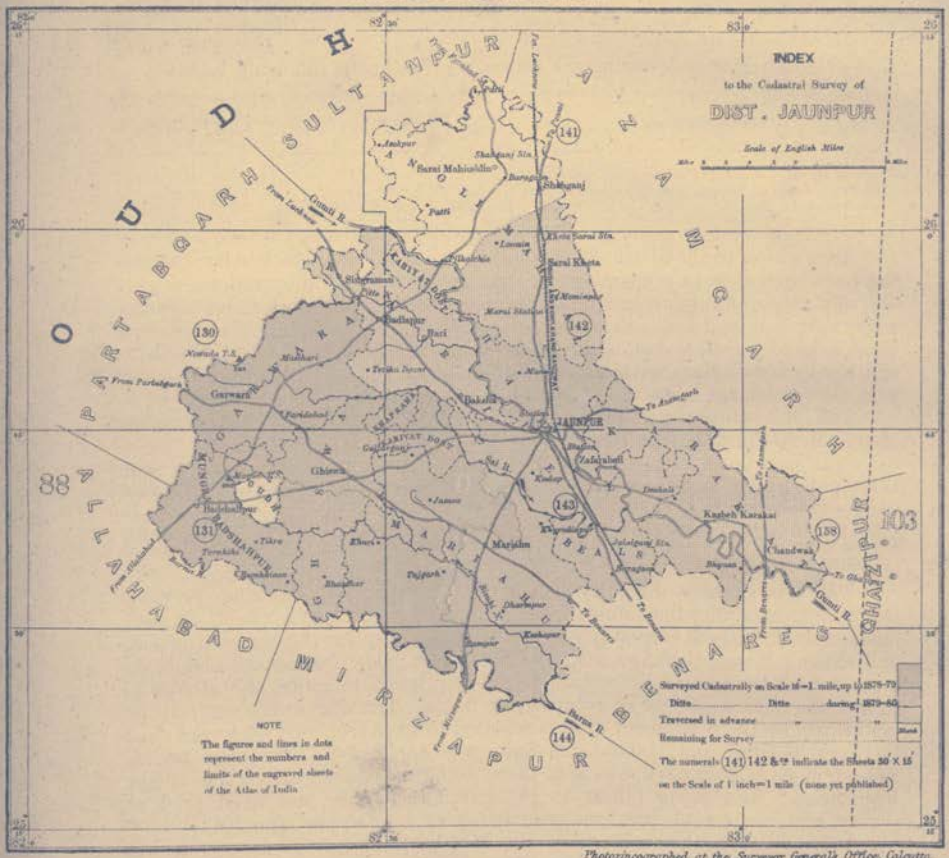
100. The field survey has been tested by 167 linear miles of checks measured by Surveyors and Assistants, and by 814 miles measured by Native Inspectors. As checks on the angular work of the boundary traversing, 20 observations for azimuth were taken, requiring average corrections to be applied to the traverses of about 2½ minutes on every 100 angles. Connections have been made with 17 stations of the Great Trigonometrical Survey, and the co-ordinates of the measured traverses have been made to agree with the values obtained from the direct distances of the triangulation. The average error of the chaining on the comparisons of 12 direct distances is 1·9 foot per mile. Colonel Anderson has adopted a novel method for instructing his Sub-Surveyors in hill sketching; his description of it is given in the Appendix.

101. In the Banda District, the small area surveyed cadastrally has added ten 16-inch sections, bringing the total number of sections for the District up to 3,364. Of these, the drawing of 1,097 has been completed during the season, and in all 2,788 sections have now been lodged in Calcutta. The remaining 576 sections are retained, partly for completion of the drawing, but chiefly for reduction to the 4-inch scale. Of the 95 general maps of Banda, noted in paragraph 132 of last report as remaining to be completed, 29 have been lodged. The season's outturn in the Mirzapur District has been mapped on 747 original sections, but this number will be increased by the separation into maps of single villages of the sheets on which the villages had been congregated, this is explained in paragraph 115 regarding the increase to the number of the Ghazipur sheets. Of these sections, 601 have been lodged in Calcutta; the remaining 146 are still somewhat incomplete. The general maps of District Mirzapur, which are to be prepared on the scale of 2 inches = 1 mile, have not yet been commenced.

102. The office of this party was inspected by the Deputy Surveyor General at Naini Tal during October. The check surveys on being compared with the maps showed the cadastral survey to have been done very accurately; and great pains were being taken to ensure accuracy in the computations of area. Colonel Anderson, as usual, has taken upon himself a very large share of the examination of the maps.*

* Colonel Anderson reports favourably on Messrs. Campbell, Little, R. B. Smart, Freeman, and Hill.

N.W.PROVINCES SURVEY



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1880

XIX.—JAUNPUR DISTRICT (No. 6 PARTY, REVENUE BRANCH).

103. This party, in strength as noted on the margin, returned from recess quarters at Hazaribagh to resume work in the Jaunpur District on the 22nd October. Field work was closed on the 15th April, when the office establishment returned to Hazaribagh.

Personnel.

Mr. E. T. S. Johnson, Deputy Superintendent 3rd grade, in charge.
„ P. A. G. Cowley, Surveyor 2nd grade.
„ J. S. Pemberton, „ 3rd grade, transferred from No. 2 party, Hanthawaddy District Survey, British Burma, from 15th October 1879.
„ J. H. O'Donel, Surveyor 4th grade, transferred to No. 8 Party, Bassein District Survey, British Burma, from 1st July 1880.
„ J. S. Swiney, Assistant Surveyor, 2nd grade.
„ E. J. Martin, „ „ „ „
„ A. W. Smart, „ „ 3rd grade, transferred to Naga Hills Topographical Survey from 1st December 1879.
„ E. H. S. Gasper, Assistant Surveyor 3rd grade.
„ C. S. Kraal, „ „ 4th grade, transferred from Kamrup Lakhiraj Survey from 1st November 1879.
and 28 Sub-Surveyors, &c.

Temporary Establishment.

237 field surveyors and others.

104. The outturn of cadastral survey during the season is given in the following table:—

Names of Parganas.	Number of villages.	Number of fields.	Area in acres.	Area in square miles.	Average size of fields.
Parganas Haveli, Zafarabad, Chandwak and portions of Parganas Mariahu, Saremu, Bialsi, Duriyapar, Pisara, and Guzara	1,371	9,25,928	3,36,220·85	525·35	0·36

In addition to the above, 315·56 square miles of village boundary traversing have been done in preparation for next season's cadastral operations.

The city of Jaunpur has fallen within the area which has been cadastrally surveyed, and has been surveyed on the scale of 16 inches = 1 mile; the boundaries of the 46 *mohullas*, or sub-divisions of the city, as well as the fields and blocks of buildings within the *mohullas*, have been surveyed in accordance with old Settlement maps.

105. Regarding the doing away with the field book of cadastral measurements, Mr. Johnson reports:—

"The *Amins* surveyed much faster on this system, and the *purtalling* proved the work to be equally good as before; but it has not been so satisfactory as when we had the field books, which used to be of great assistance to draftsmen when inking in the maps; for in many instances, where the ground is intricate, considerable difficulty is experienced in making out the items, and portions of the 16-inch sheets of this intricate nature have had to be sent out several times for re-survey." * * * * * *

106. Considerable difficulty had been experienced during the previous season in ascertaining the boundaries of fields in rice lands, as a "field" in such lands often consists of several plots or terraces prepared for the purpose of rice cultivation; it was, therefore, arranged that the "field" boundaries should be marked with low mounds of earth by their proprietors to guide the *Amins* as to how the terraces should be grouped into fields. The demarcation of village boundaries by the Settlement Staff is reported to have been very backward; and in Parganas Ungli and Mahaul, the Surveyors are said to have been several times obliged to stop work, owing to there being no marks along the village boundaries. The stone pillars at the trijunctions were not fixed prior to survey, and considerable inconvenience and delay were caused thereby.

107. Owing to the abolition of the field-book system of survey, it was thought necessary by the Executive Officer to increase the usual amount of *purtal* or check survey. The total length of these check surveys run by Assistant Surveyors is 215 miles, and by Native Inspectors 1,814 miles; it is reported that the quality of the work was found to be very good. As checks on the angular measurements of traverses, 28 observations for azimuth were taken, showing an average correction to be required of one minute per 100 angles.

108. The season's outturn has been mapped on 1,069 sixteen-inch sections; many of these consist of several villages congregated on one sheet, but the number of sections will be increased when the villages are separated during publication. The sections have been sent down to Calcutta for publication at various times during the season; now (31st December 1880) all, except 16 kept back on account of disputed boundaries, have been lodged, and 825 sections have been published.

The general maps, on the scale of 2 inches = 1 mile, have been brought up as far as the maps of the cadastral survey have been available for reduction. None of the sheets are as yet entirely filled up to margin.

109. To complete the cadastral survey of the Jaunpur District, there remains an area of 472 square miles, which will be finished next season.

After completing Jaunpur, this party might have been suitably employed on the survey of the Benares District; and it is to be regretted that the Government of the North-Western Provinces should have ordered the survey of the Benares District to be deferred for the present. The party has been brought to a high state of efficiency under the superintendence of Mr. Johnson; and should the cadastral survey of any District in any other Province be in contemplation, it is very desirable that the services of this party should now be utilised, as it has been found from experience that a new cadastral party when required is not readily organised; it is hoped, therefore, the party may be saved from dispersion.

110. The recess office of the party was inspected by the Deputy Surveyor General at Hazaribagh during September. An examination of the checks showed the surveys to have been carefully executed, and the state of the maps and other records reflects great credit on Mr. Johnson's watchful supervision.*

XX.—GHAZIPUR DISTRICT (NO. 4 PARTY, REVENUE BRANCH).

111. This party, of which the strength is given in the margin, returned from recess quarters at Naini Tal to resume field work in the Ghazipur District on the 26th October 1879. Field operations were continued until the 30th April 1880, and the recess office was again opened at Naini Tal on the 9th May.

Personnel.

Major W. Barron, Deputy Superintendent 3rd grade, returned from privilege leave and resumed charge on the afternoon of 3rd November 1879.
Mr. E. C. Barrett, Assistant Superintendent 2nd grade, in charge up to the 3rd November 1879, transferred to No. 8 Party, Bassein District Survey, which he joined on the 11th November 1879.
„ W. A. Wilson, Surveyor 3rd grade.
„ H. T. Hanby, „ 4th „
„ S. O. Madras, Assistant Surveyor 2nd grade.
„ W. D. Corbett, Ditto 2nd „
„ J. Murphy, „ 3rd „ transferred to No. 2 Party, Hanthawaddy District Survey from 1st December 1879.
„ L. F. Berkeley, Assistant Surveyor 4th grade.
„ W. H. D. Ewing, „ 4th „ went on leave (m. c.) for 2 months from 2nd July, and was transferred to No. 8 Party, Bassein District Survey.
„ C. B. Taylor, Office Assistant,
and 31 Sub-Surveyors, &c.

Temporary Establishment.

173 field surveyors and others.

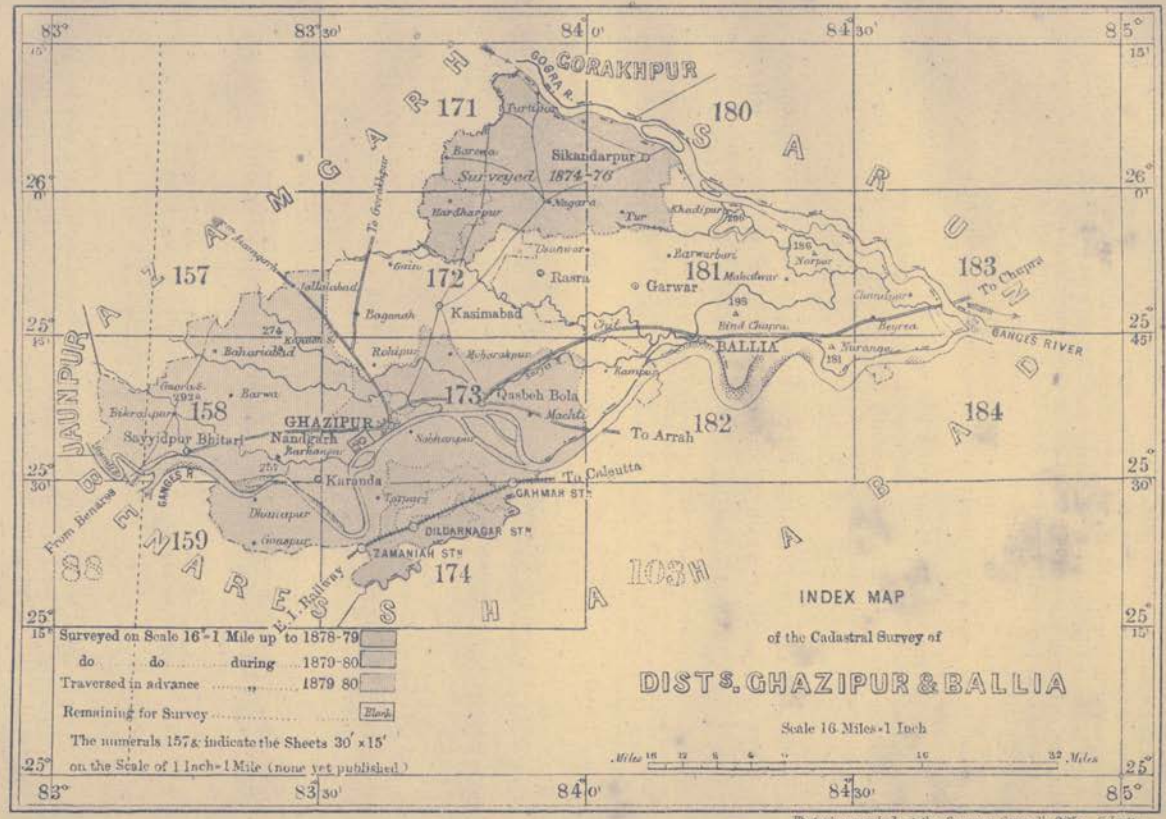
112. The outturn of completed survey has been as follows:—

Parganas.	No. of Villages.	Area in square miles.
Zamaniah	181	171·91
Mahaich	133	87·52
Karanda	88	43·11
Ghazipur	299	98·58
Muhammadabad . . .	721	177·78
Sayyidpur Bhilari . . .	102	37·85
Total . .	1,524	616·75

An overlap of 69·69 square miles on the scale of 2 inches = 1 mile has also been surveyed in Districts Benares and Shahabad; and the boundary traverse survey of 1,131 villages, area 399·23 square miles, has been prepared in advance

* Mr. Johnson reports very highly of his senior assistants, Messrs. Cowley, Pemberton, O'Donel and Swiney.
He also expresses great satisfaction at the manner in which Messrs. Martin, Smart and Kraal have performed their duties.
Mr. C. Rivett, Sub-Surveyor, is well reported on, and also the following individuals of the Native establishment, viz.:—
Baboo Guru Pershad Chuckerbutty, Shimbhu Nath, Kanhia Lall, and Kedar Nath, Computers; and Ghulam Hyder Khan, Draftsman.
The Native Doctor Russick Lall Mookerjee is said to have been attentive to his duties.

N. W. PROVINCES SURVEY.



Photozincographed at the Surveyor General's Office, Calcutta.

NOTE

The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India

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1880

SURVEY OF INDIA OFFICE BOMBAY

for the field measurements of next season. The City and Cantonments of Ghazipur have been surveyed, on the scale 16 inches = 1 mile, as part of the cadastral operations.

113. Regarding the system of cadastral survey and the change in the manner of recording the field areas, referred to in paragraph 155 of last report, Major Barron reports as follows :—

"No field books of field measurements were prepared. The measurements were plotted on the original plans at once in the field. This gave opportunity of testing the accuracy of the work on the spot, and is a far quicker method than the system of recording in a field book and plotting afterwards. There were no *khasras* prepared for the Settlement Officer, as formerly used to be done; instead of these, he is supplied with copies of the field area calculation books having a column added for remarks, which require no additional labour in their preparation. It is calculated that from these two simplifications, *viz.*, doing away with the field books of measurements, and the *khasras*, about 100 square miles additional area have been surveyed, and the work has cost less by Rupees 30 per square mile than it otherwise would have done."

114. The field survey has been tested by 497 linear miles of check surveys measured by the Deputy Superintendent and his European Assistants, and by 1,081 miles of checks measured by Native Inspectors. Connections have been made with four stations of the Great Trigonometrical Survey, and the values of the direct triangulation rays have been made use of for correcting the chain measurements of the traverses; the average of the corrections required, in two cases where *plus*, is ·5 foot per mile, and in six cases where *minus*, 1·43 foot per mile. To check the angular work, 88 observations for azimuth were taken.

115. The season's outturn of 1,524 villages was originally mapped on 861 sheets, scale 16 inches = 1 mile, having in many instances several villages congregated on one sheet. This system, which was introduced with the double object of reducing the labour of preparing the sheets in executive offices and of lessening the cost of publication, has not been approved by the Government of the North-Western Provinces, who require that each village should be shown singly; the villages are now, therefore, being separated, so that the number of sheets will be increased considerably. The sheets, as they have been completed, have been sent down to Calcutta for reproduction by photozincography; and, up to 1st October, 510 sheets had been forwarded comprising an area of 352 square miles. Besides providing for the speedy publication of the sheets, Major Barron also supplied the Settlement Officer with 111 tracings of the maps of villages in the low-lying lands of the Ganges River, so as to enable the Record of Rights in these villages to be prepared during the year of survey.

The general maps, on the scale of 2 inches = 1 mile, are being prepared by reduction from the 16-inch plans, as the cadastral survey progresses; but none of the maps have yet been completed.

116. The demarcation of trijunctions, which is carried out under orders of the Settlement Officer, is very backward in some parganas, and a good deal of the boundary traverse survey had to be carried on before the trijunction stones had been imbedded, which is always an objectionable procedure. There are several disputes still unsettled, and several discrepant boundaries caused by defective demarcation; from both causes, the maps of 88 villages remain incomplete.

Baked clay cylinders have been imbedded at all theodolite stations on the village boundaries.

117. Referring to paragraph 151 of last report, in which it is stated that, by reason of the ruling of the Government of the North-Western Provinces requiring the boundary of districts Budaun and Bareilly,—where falling on the Ramgunga,—to be the main stream of the river, a difficulty had arisen as to how the gaps and overlaps between the surveys of Budaun and Bareilly should be accounted for on the maps of the recent survey of Budaun, the difficulty has been disposed of in the following manner: It had previously been overlooked that a special survey of the village boundaries in alluvial lands of the Ramgunga River, "to facilitate the annual settlement of the alluvial lands," had been carried out in 1852-53 by Lieutenant T. J. Burgess, at which time a set of 4-inch maps had been prepared showing continuously the villages of both the adjoining Districts on one projection. It was found, on the maps being referred to, that the special survey had been extended beyond the action of the river, and that the points, which had been fixed as the trijunctions of the village boundaries on the high lands, had been identified and adopted as the village

trijunctions during the recent survey of the Budaun District; it was thus practicable to make a combination of the two surveys, and Major Barron has introduced the boundaries of Lieutenant Burgess' survey on the village maps of Budaun, thus showing the limits to which the village lands may be extended, should it be desired to uphold the settlement of 1852, while he has retained the course of the main stream of the Ramgunga as it flowed during season 1878-79, the year of survey, as the present record of the District boundary.

118. An opportune illustration of the advantage of possessing a record of the boundaries of villages bordering on a shifting river,—in the manner of the survey under Lieutenant Burgess,—occurred during last season with respect to a disputed boundary in the valley of this very Ramgunga River, and on the same portion where the boundaries of the old survey have been introduced on the Budaun maps. The boundary in question, which entirely falls on land liable to submersion, had long been under dispute; and an attempted restoration of an old line by the Civil Authorities in 1873 having failed to give satisfaction, the Collector of Bareilly reported through the Board of Revenue that a proper adjustment could only be made with the aid of the Survey Department. The Government of the North-Western Provinces consequently requested that a Surveyor might be deputed to do the work, and the boundary has been restored in accordance with Lieutenant Burgess' map by a Sub-Surveyor deputed from Major Barron's party.

119. The recess office of this party was inspected by the Deputy Surveyor General at Naini Tal during October. The same state of high efficiency is being maintained as has frequently been reported of the Establishments under Major Barron's supervision.*

XXI.—HANTHAWADDY DISTRICT, BRITISH BURMA (No. 2 PARTY, REVENUE BRANCH).

120. This party, which had been of half strength during the previous year, was raised to full strength at the beginning of the field season, and, with the establishment as noted on the margin, resumed operations in the Syriam Township of the Hanthawaddy District early in December 1879.

Personnel.

Captain J. E. Sandeman, Deputy Superintendent 3rd grade, in charge.
Mr. F. Grant, Surveyor 2nd grade, transferred from late 2nd division, Jhelum and Sirsa Survey, from the 1st November 1879.
„ H. Dowman, Surveyor 4th grade, transferred from No. 7 party, Khorda Estate Survey, from the 1st November 1879.
„ C. A. K. Scanlan, Surveyor 4th grade, transferred from Surveyor General's Office from the 1st November 1879. On sick leave from 9th June 1880. Resigned from 1st October 1880.
„ D. A. King, Assistant Surveyor 1st grade.
„ J. McHatton, Assistant Surveyor 2nd grade, transferred from Head-Quarters Office, Calcutta, from the 1st January 1880.
„ G. E Parker, Assistant Surveyor 3rd grade.
„ J. Murphy, „ „ „ transferred from No. 4 party Ghazipur Survey, from the 1st December 1879, temporarily attached to Leveling party from the 1st February to the 31st May 1880.
„ B. M. Wilson, Assistant Surveyor 3rd grade, transferred from No. 9 party, Cuttack Irrigation Survey, from the 1st December 1879, and 21 Sub-Surveyors, &c.

Temporary Establishment.

166 field surveyors and others.

Leveling.

Mr. J. Murphy, Assistant Surveyor 3rd grade, Leveler from the 1st February to the 31st May 1880.

Hindustanis and Burmans have been employed in about equal numbers as Field Surveyors. The Burmans, who had been trained by Captain Sandeman during the recess of 1879, fully justified the trouble that had been taken with them; and after instruction during another month in the field, the majority turned out fair Surveyors, realising even more than might have been expected from men in their first year of service. Burmans have been very largely employed in office as computers of area, and as draftsmen. All the measurers and flagmen were taken down from India, the experience of the previous season having proved that these men could not be hired in sufficient numbers in Burma. No village labour of any kind was obtained. A good deal of rain in April obstructed the operations, but the party did not return to recess quarters until the middle of May, when the monsoon rains had fairly set in.

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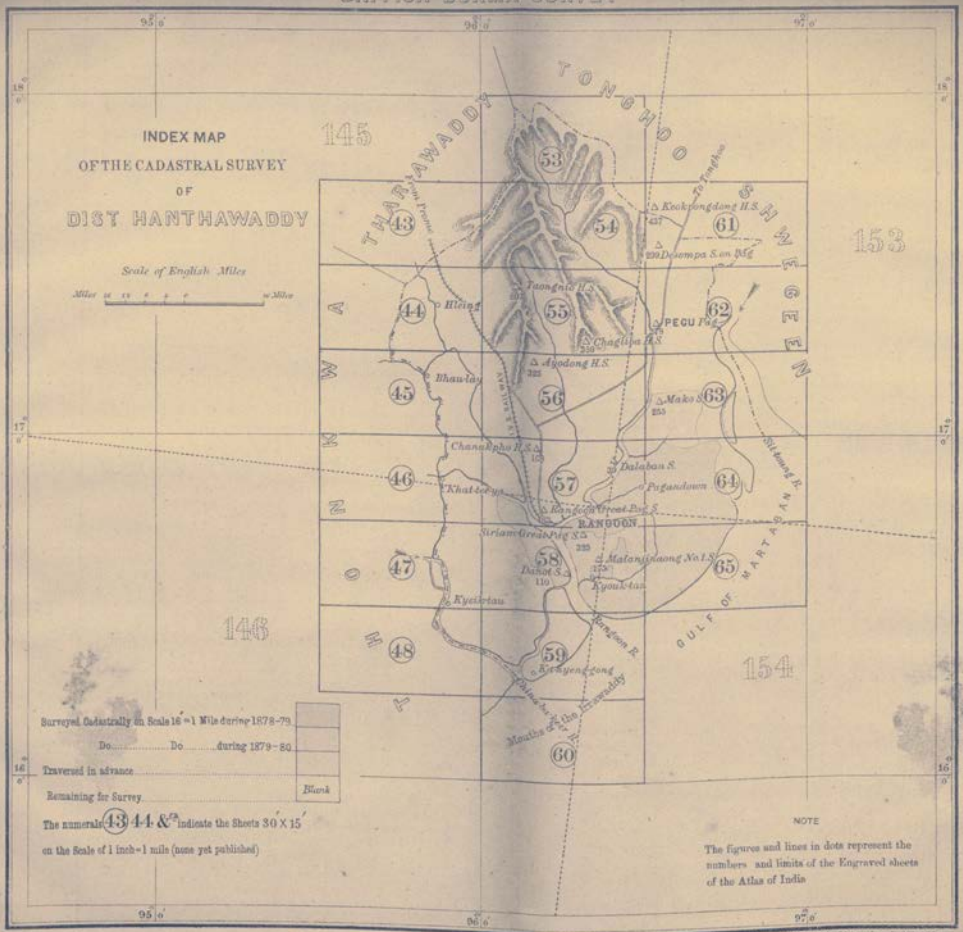
* Major Barron commends Messrs. Wilson, Hanby and Madras for the way in which they supervised the work of their respective sections of the establishment, and Messrs. Corbett and Berkeley for the ability and energy with which they performed the duties entrusted to them.
Mr. C. B. Taylor, Sub-Surveyor, is also commended, and the Native Staff are said to have all worked well.

BRITISH BURMA SURVEY


INDEX MAP
OF THE CADASTRAL SURVEY
OF
DIST HANTHAWADDY
Scale of English Miles
Miles
Miles
95° 0'
96° 0'
97° 0'
18° 0'
17° 0'
16° 0'
145
146
153
154
HANTHAWADDY
TONGHOO
SHWEGYIN
PEGU
MARTABAN
GULF OF
R. SITTANG
R. PEGU
R. HLAING
R. PAZUNDAUNG
R. RANGOON
R. PUNGALOW
R. KYAIKKAMI
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R. KYAIKTAN

121. The unit of survey has been the field; and the scale of survey has been that of 16-inches = 1 mile. The "holding" survey of the first season (paragraph 214 of last report) has been revised, and the area has been again included in the "field" survey of the present season. The total area of field survey is 762·6 square miles, which embraces the whole of the Syriam Township, excepting 31 square miles surveyed last year, and about 65 square miles of jungle land at the north-east extremity of the township, which is liable to be flooded by the sea and where there are no villages. Preparatory boundary traversing has also been done in 130 square miles in the Pegu Township and 115 square miles in the Angyee Township. At the request of the Chief Commissioner, the preparatory traversing has also been done for 60 square miles in the Tharawaddy District in anticipation of the sanction of the Government of India to the cadastral survey of that district, which had been recommended. The Tharawaddy District survey has since been ordered; and the traversing which has been done will enable the field measurements to be commenced without delay by the new party which has been raised for the Tharawaddy District. A small section of this party has been employed on leveling, and their work is reported on with the other leveling operations of the Department.

122. In the completed area of 763 square miles,—after rejecting the large patches of jungle and waste, but including minor details of waste, &c., mixed with the cultivation,—there are found to be 576 square miles of cultivated country with fields numbering 4,16,402, which gives an average size for the fields of ·9 acre.

The completed area includes 20 Waste Land Grants, having a total area of 13,457 acres.

The field survey measurements were plotted direct on the 16-inch sheets, no field books having been kept.

Check surveys have been measured aggregating 465 linear miles. These have proved the general work to be good, but they also brought to light some errors, and several resurveys were necessary. Azimuths were observed at 31 stations as checks on the angular measurements of the traverses. The linear measurements have been tested by comparison with 10 rays of the Great Trigonometrical Survey, showing in them an average error of—9·25 feet per mile.

No permanent demarcation of boundaries has been done previous to survey; but during the course of the boundary traversing, baked clay cylinders have been imbedded at selected theodolite stations, and these cylinders are intended to take the place of all other permanent marks.

123. At the commencement of the field season, a Settlement Establishment took up the examination of the 31 square miles of field survey, which had been completed during the previous season, using tracings of the maps which had been got ready during the recess; and it was desired by the Chief Commissioner that continuous work should be supplied to this Establishment in order that the Settlement of six Circles might be carried out during the season, *pari passu* with the Survey. Tracings of the maps of these Circles, with field area statements, were therefore furnished as soon after survey as the drawing of the maps and computation of areas could be done; and, subsequent to the settlement examination, the maps have been corrected by remeasurement, where errors or omissions were discovered; so that in these six Circles, which include an area of 432 square miles, the successive operations of Survey, Settlement investigation, and the final rendering of the maps ready for publication have all been done in one season. The Settlement investigation includes the grouping of the fields into cultivators' holdings; but the boundaries of the holdings are not distinguished on the maps, as the holding boundaries are liable to change; and it is intended that a Settlement investigation regarding these boundaries should be made annually. The annual changes will be noted on fresh copies of the maps, of which 30 copies of each are being printed. There is no cognizance of the holdings in any of the survey records, but the average area of the holdings in the Circles which are settled is given by the Settlement as being 4·3 acres in rice lands, and about 3 acres in garden lands. The average area of the kwins has been ascertained by the survey computations to be 1,722 acres.

124. In the six Circles, of which the Settlement examination has been completed, there are 193 kwins, which are mapped on 619 sheets. These sheets have been received in Calcutta and are now being published by photo-zincography. In the five Circles not examined there are 101 kwins, which are mapped on 456 sheets. Manuscript tracings of these sheets have been supplied, on which the Settlement examination will be carried out; and the sheets will not be forwarded for publication, until all errors or omissions that may be discovered have been rectified.

In addition to the 16-inch cadastral sheets, the preparation of the general maps on the 2-inch scale has been proceeded with, as far as the cadastral area has extended. This area falls on eleven of the standard sized sheets, but of these only three could be completed up to margin.

125. One of the Assistant Surveyors of this party has been employed, in conjunction with an Assistant Surveyor from the Trigonometrical Branch, in measuring a traverse from a Trigonometrical Survey station for about 60 miles along the sea-coast for the purpose of determining the latitudes and longitudes of two marine beacons recently placed opposite the Krishna Shoal. The measured traverse was substituted for a series of triangles to determine the positions of these beacons, as from the nature of the country triangulation would have been very tedious and expensive. Accuracy in the traverse has been provided for by the independent measurements of the two Assistants.

126. Captain Sandeman's camp in the Hanthawaddy District was visited by the Deputy Surveyor General during March. The completion of the maps and area statements to meet the requirements of the Settlement Officer was then being prosecuted most vigorously, and great credit is due to Captain Sandeman for his arrangements, which allowed of the results of his survey being so speedily utilised for Settlement purposes. The pains which Captain Sandeman had bestowed on the training of Burman field Surveyors, was abundantly evident in the large share of the season's outturn which had been done by these men.*

XXII.—BASSEIN DISTRICT, BRITISH BURMA (No. 5 PARTY, REVENUE BRANCH).

127. The orders of the Government of India having been received for the despatch of a party for the cadastral survey of the Bassein District, British Burma, (conveyed in letter No. 366, dated 12th August 1879), Major Andrew who had been temporarily employed in the Head Quarters Office was nominated to the charge; and the party was formed partly of Surveyors and others of the late Cuttack Irrigation Survey, and partly of those withdrawn from Cachar. Before the final constitution of the party was determined on, Major Andrew was directed in September 1879 to proceed to Bassein, that he might judge whether the nature of the country required any special organization in his Establishment, and also that he might make all needful preliminary arrangements. On Major Andrew's return to Calcutta in October, the members of the different classes were collected, and the party numbering (with measurers and line cutters, all of whom had to be taken from India) about 840 men embarked for Bassein early in November. Field operations were commenced soon after the 16th November, the date on which the party reached Bassein.

Personnel.

Major D. C. Andrew, Deputy Superintendent 3rd grade, assumed charge on the 11th November 1879.
Mr. E. C. Barrett, Assistant Superintendent 2nd grade, joined on the 11th November 1879, proceeded on furlough on the 22nd July 1880.
„ H. R. Littlewood, Surveyor 3rd grade, joined on the 8th November 1879.
„ J. H. O'Donel, Surveyor 4th grade, joined on the 26th July.
„ P. Ford, Surveyor 4th grade, joined on the 5th November 1879; died in Calcutta, 21st November 1880.
„ G. Campbell, Assistant Surveyor 3rd grade, joined on the 11th November 1879.
„ C. W. J. Ford, Assistant Surveyor 3rd grade, joined on the 11th November 1879.
„ W. H. D. Ewing, Assistant Surveyor 4th grade, joined on the 9th August 1880,
and 29 Sub-Surveyors, &c.

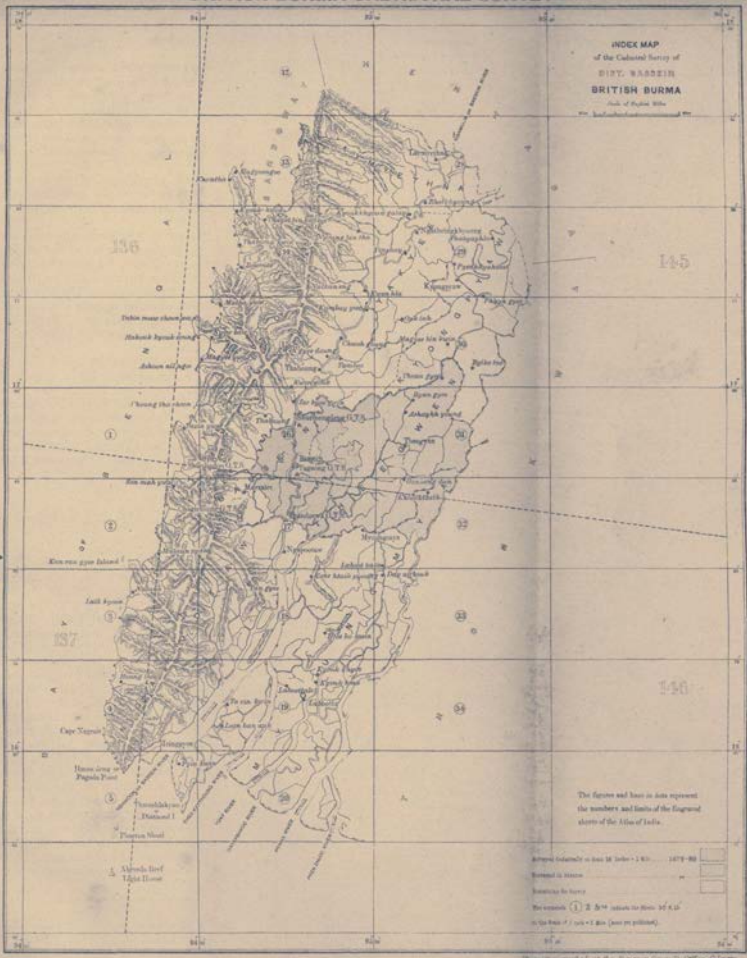
Temporary Establishment.

144 field surveyors and others.

* Captain Sandeman reports of his Assistants as follows:—

"To the senior Officers, Messrs. Grant, Dowman, and King, I am indebted for the zeal with which they have worked. Messrs. M'Hatton, Parker, Murphy and Wilson have ably aided the senior Officers. Mr. M'Hatton especially has shown great industry"—also:—"as a rule the Sub-Surveyors have worked well; I may particularly mention Unganothoo and Hillaludd.n."

BRITISH BURMA CADASTRAL SURVEY



Photolithographed at the Surveyor General's Office, Calcutta.

Published under the direction of Major-General J.T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, November 1880.

128. The survey was commenced in the Bassein Township, where the boundaries of kwins had been demarcated, and an area of 346 square miles, comprised in 10 Circles, has been completed. Field measurements have also been taken over an additional area of 55 square miles; but in this area the survey has still to be tested. The preliminary traversing for the work of next season has been carried out over a further area of 449 square miles.

The country brought under survey is much intersected by tidal creeks, and the jungle land which fringes the creeks is, as a rule, liable to be submerged, while cultivation has been extended over nearly all the land beyond tidal influence. In the completed area, about 200 square miles are cultivated and the remaining 146 square miles consist either of waste land or of water. The average size of the fields is ·75 acre.

The field measurements have been recorded on field books, as in the absence of preliminary traversing there were no boundary maps ready on which the fields could be directly plotted. The survey has been tested by 400 linear miles of check surveys, of which 16 miles were measured by Assistant Surveyors and 384 by Native Inspectors. There are about 2 miles of these checks in each of the 188 kwins that have been surveyed. Check azimuths have been observed at stations on the main traverses averaging about 6 miles apart. One station of the Great Trigonometrical Survey has been incorporated with the traverses.

129. The demarcation done by the Civil Officers in advance of the Survey, consisted of light posts intended only to be temporary, and a commencement was made during the season to carry out a permanent demarcation, by replacing the posts at the trijunctions of kwins by others of a larger size; but this description of mark was afterwards abandoned in favour of a burnt-clay cylinder, which will be imbedded at all tri-junction theodolite stations, and at other selected stations on the kwin boundaries not more than half a mile apart.

130. The Chief Commissioner was very desirous that a commencement of the Settlement should be made during the first season of survey; and to enable this to be done, it was necessary that tracings of the kwin maps and statements of the areas of fields should be furnished to the Settlement Officer as early as possible. These tracings and statements were supplied for three Circles, in area = 76·6 square miles; the Settlement investigations were then carried out, and finally the maps were corrected by remeasurements where errors or omissions were discovered during the investigation.

131. Major Andrew reports the following to have caused delay in the progress of his operations:—

1st.—Difficulty of communication.—The country being so largely intersected with creeks, all communication is necessarily carried on by water; but boats were available for hire only in small numbers, and could with difficulty be procured even for the temporary convenience of ferrying the survey squads over creeks in the course of their daily work.

2nd.—The heavy line-clearing.—Fringes of dense jungle are invariably found on the banks of the numerous creeks, and, as the latter usually form the kwin boundaries, a very large number of the boundary lines had to be cleared through jungle. For the future, the lines will not be taken so close to the creeks, but will be kept, as far as possible, clear of the jungle.

3rd.—Defective demarcation.—A large amount of extra work was caused owing to a misunderstanding regarding kwin boundaries; many boundaries intended to follow the edges of fields were first taken straight on account of the insufficient number of posts that had been erected.

4th.—The early setting in of the rains.—Rain commenced to fall about 1st April and greatly retarded the field work, which on this account had to be continued until June, or at least a month longer than had been expected.

5th.—The sickness of the establishment.—The disease most prevalent was dysentery, which is believed to have been caused in a great measure by inferior and adulterated food. There were 23 deaths during the season.

132. The head-quarters of the party at Bassein were visited by the Deputy Surveyor General during March. The work was then being prosecuted energetically, in face of difficulties which all the members of the party had to contend with, in the exceptional features and circumstances of a new country.

133. The party has to regret the loss by death of one of its members, Mr. P. Ford, Surveyor 4th grade, who manfully remained at his post after being attacked by severe illness, but who succumbed to the disease he had contracted, shortly after reaching Calcutta where he had come on medical leave.*

MISCELLANEOUS.

XXIII.—SURVEYS IN THE DARJEELING DISTRICT, AND IN SIKKIM.

134. On the termination—at the end of the field season of 1877-78—of the triangulation and geographical operations in Assam on which Lieutenant Harman and his party had been employed for some years, the party was sent to recess at Darjeeling in order to be available for the prosecution of similar operations in Sikkim, to those on which they had been engaged in Assam. It happened, however, that a variety of survey operations were urgently wanted in the Darjeeling District for the demarcation of new boundaries and the settlement of disputes regarding old boundaries and for various other local requirements. The Government of Bengal urged that these surveys were of far more immediate importance than a geographical survey of Sikkim, and recommended that Lieutenant Harman and his party should at once be employed on them. The Surveyor General readily assented to this proposal as no other survey party was available for the purpose at the time, and the amount of work to be done was believed to be small; moreover, the recent amalgamation of the three branches of the Survey Department rendered it desirable that this party, which originally belonged to the Trigonometrical Branch, should have an opportunity of acquiring practical experience in large-scale surveys of lands and boundaries which had hitherto been the special province of the Surveyors in the Revenue Branch of the Department.

Personnel.

Lieut. H. J. Harman, R.E., Assistant Superintendent in charge.
Mr. W. O'Sullivan, Surveyor 4th grade.
„ W. Robert, Assistant Surveyor 2nd grade.
„ D. J Collins, „ 3rd „
Mohibulla Khan, Sub-Surveyor.
Bhawani Din, „ and 4 others.

135. The general programme of the operations in the Darjeeling District and the details of the operations completed up to the end of 1878-79, are given in paragraphs 236 to 239 of the report for last year. In July 1879 it was believed that so little work remained to be done within the limits of the District itself that the survey of Sikkim might be commenced in the following field season. Arrangements were made accordingly, and early in October Lieutenant Harman started for Northern Sikkim and sent Mr. Robert into Western Sikkim, leaving the remaining surveyors, European and Native, to complete the field work in the Darjeeling District.

136. The result has been unfortunate in various respects. Little more than a month had elapsed after his departure from Darjeeling, when Lieutenant Harman was so badly frost-bitten at the Donkia Pass, on the frontier of Thibet, that he lost eventually four and a half of his toes, and had to return, leaving his work in Sikkim incomplete. Moreover, as regards the work to be done in the Darjeeling District, not only was it found to be much more laborious and extensive than Lieutenant Harman had supposed in July, but it was materially

* Major Andrew reports o Mr. J. H. O'Donel, that he has given entire satisfaction in all he has undertaken since he joined the party, on 30th July.

added to afterwards, because the local officers in all departments and the tea-planters, finding a survey party available on the spot, applied for its services on every occasion when surveyors were wanted to relay old boundaries or demarcate new ones, or to perform any of the varied duties which they are liable to be called on to undertake. Under the circumstances, Lieutenant Harman's absence in Sikkim, though only for half the field season, is to be regretted, as his presence on the spot and direct supervision were required to enable the District work to be completed, and the survey party transferred to other duties as speedily as had been desired by the Government of Bengal.

137. The operations in the Darjeeling District having already formed the subject of special reports to the Government of India, it is unnecessary to say more here than that the surveyors have been very fully occupied and a large amount of work has been performed, in the station of Darjeeling, in the Hope Town estates, in the Government Khas lands, in the lands east of the Teesta River which are required for tea cultivation, in the tracts which are reserved for native cultivation in the hills of the Daling Sub-Division, and on a number of boundary lines of which the longest and most important is the boundary between the Darjeeling and the Jalpaiguri Districts. The blocks of land newly taken up for cinchona plantations in Sittong have been surveyed. The congregation of the 16-inch settlement survey maps of the jotes in the Terai on the 4-inch scale into a frame-work of triangulation and traverses specially constructed for the purpose by the professional survey, is well advanced; and much data have been collected for the preparation of a new edition of the general map of the District, on the 2-inch scale, corrected up to date.

138. For the survey of Sikkim, Lieutenant Harman had arranged to undertake in person the whole of the country lying to the east of the range running south-east from Kanchinjinga, and assigned the country to the west to Mr. Robert. He proceeded in the first instance, to the snowy ranges on the frontier between Sikkim and Tibet hoping to survey them during the brief interval between the cessation of the rains and the setting-in of the winter with its heavy snow-falls. Going up the main valley to the point of junction of the Lasing and the Lachung Rivers, he ascended the Lachung Valley and reached the Donkia Pass on the boundary. Here his feet were badly frost-bitten as already stated; but with most commendable persistence and energy, he bravely continued his work under great difficulties, going about as best he could, on coolies, or ponies, or crutches. On returning to the junction of the two rivers he ascended the Lasing Valley and reached the Kangra Lama Pass, also on the boundary. He subsequently ascended the summits of Kinyong, Nochego and other mountains, and penetrated into parts of Sikkim which no European had before visited. He was in Sikkim for about $3\frac{1}{2}$ months, during which he surveyed an area of over 1,000 square miles on the scale of $\frac{1}{4}$ inch to the mile, determined the heights of about 300 positions of more or less importance by barometric and boiling-point observations, and executed a large amount of triangulation.

139. Mr. Robert succeeded in making a survey on the $\frac{1}{2}$-inch scale of an area of about 600 square miles in Western Sikkim, including the line of boundary with Nepal. From the numerous commanding points on this mountain frontier line he could see most of that part of Nepal which lies to the east of the southern spurs of Mount Everest, and was able to sketch an area of about 900 square miles, besides fixing a large number of points on the surrounding hill ranges and in Sikkim. Lieutenant Harman finds that Dr. Hooker's work in Nepal will combine well with Mr. Robert's, which is very satisfactory.*

* Lieutenant Harman reports that the steady, persistent manner in which Mr. Robert achieved all that he attempted, and all that could possibly have been expected of him, is most praiseworthy.

GEOGRAPHICAL.

XXIV.—GEOGRAPHICAL OPERATIONS IN AFGHANISTAN AND BELUCHISTAN.

140. The Officers who had operated with the army in Northern Afghanistan, during the first year of the war, were withdrawn from the field when the army retired on the conclusion of the Treaty of Gundamak, and were occupied in bringing up their calculations and completing their maps at the Mussoorie Head-Quarters, when intelligence was received in September 1879 that an army would at once be sent to Kabul in consequence of the massacre of the British Embassy. Immediate measures were, therefore, taken to organize two field parties, one under Major R. G. Woodthorpe, R.E., to proceed *viâ* Kuram and the Shutargardan to join the column under General Sir F. Roberts; the other under Captain Holdich, R.E., to proceed *viâ* Peshawar and Jellalabad to join the column under General Bright. The formation of these two parties was deemed expedient so as to secure as much topography as possible along the two lines of advance. Eventually both parties met at Kabul, where they were employed in making the most of every opportunity which was presented by the movements of the forces to add as much as possible to the geography of the surrounding country; in continuation of the preceding surveys, they operated westwards and southwards, up to the Pughman Range and over almost all the country which is drained by the Logar, Shiniz, and other affluents of the Kabul River.

141. Some additional geography was obtained in Southern Afghanistan, between Kandahar and Girishk, and along the valleys to the west and north-west of Kandahar. A connection with the operations in Northern Afghanistan was also made by the survey of the route from Kandahar to Ghazni, through the Khushk-i-rud, Tarnak and Ghazni Valleys. In Beluchistan a rough reconnaissance was made of a considerable portion of the country north of Sibi inhabited by the Marri tribes, and detailed surveys were commenced in the plains around Sibi and Dadur.

142. These operations will now be described in the following order: 1st, Northern Afghanistan; 2nd, Southern Afghanistan; and, 3rd, Beluchistan; to be followed by, 4th, a report on the general organization of survey operations with an army in the field.

1.—THE OPERATIONS IN NORTHERN AFGHANISTAN.

143. On the re-occupation of Gundamak, in November 1879, by the advanced brigade of General Bright's division under Brigadier General C. Gough, the survey party under Captain Holdich, R.E., joined the brigade. Captain C. Strahan, R.E., had previously executed a triangulation in the Jellalabad Valley and beyond as far as Gundamak, and had fixed points on the Karkacha Range to the west, which were of much use in extending the topography into the plains of Kabul. Additional triangulation was required to connect the operations in this quarter with those of Major Woodthorpe in the Kuram Valley and around the Shuturgardan Pass, and to complete the general system of triangulation in Northern Afghanistan. This was effected in due course as opportunities offered on the advance of the troops.

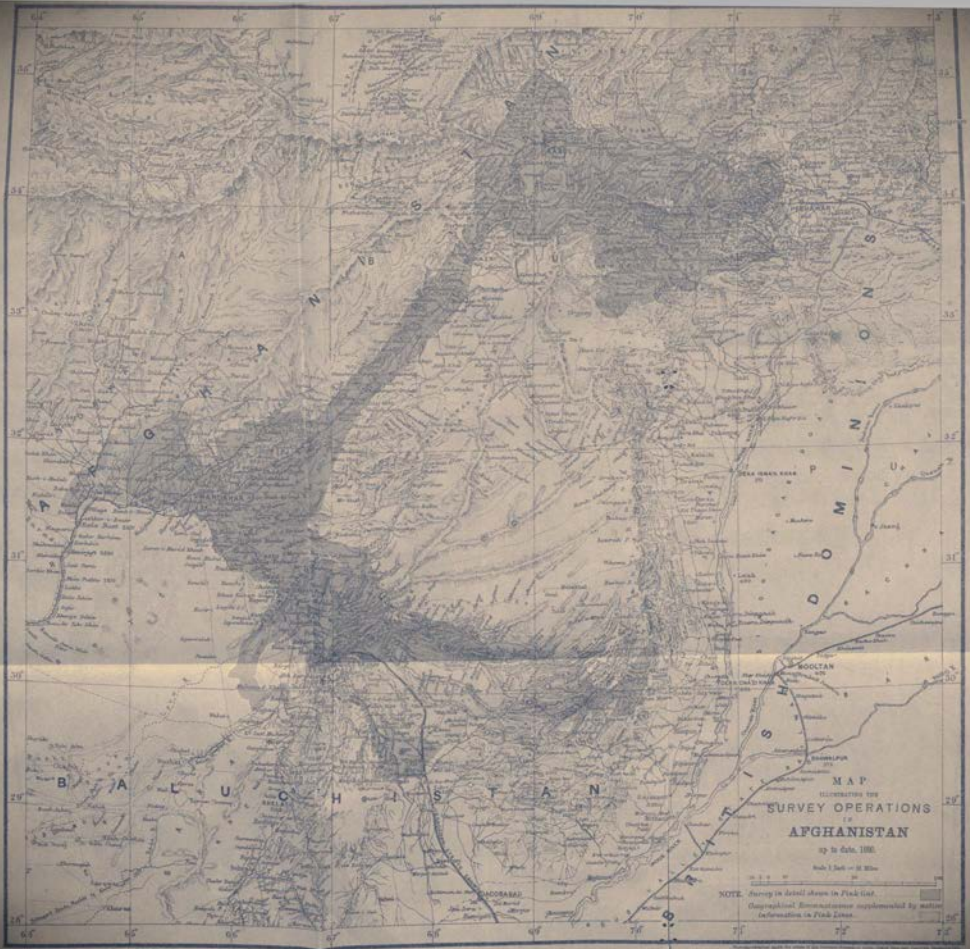
Personnel.

Captain T. H. Holdich, R.E., Officiating Deputy Superintendent 3rd grade.
Mr. T. E. M. Claudius, Surveyor 4th grade.
„ W. W. McNair, Assistant Surveyor 1st grade.
Two sub-surveyors (The Munshi and Bozdar).

144. Major R. G. Woodthorpe's party, which had proceeded *viâ* the Kuram Valley, reached Ali-Kheyl on the 4th October, a few days after the force under General Sir F. Roberts had advanced on Kabul. Here it was detained until nearly the end of October, when General Hugh Gough arrived at the Shuturgardan Pass with orders to withdraw the garrisons from the posts there and at Ali-Kheyl, and take them on to Kabul. A day's halt at the Shuturgardan enabled Major Woodthorpe to ascend a hill in the neighbourhood from which a good view was obtained, enabling much work

Personnel.

Captain (Brevet Major) R. G. Woodthorpe, R.E., Assistant Superintendent, 2nd grade.
Captain G. W. Martin, Assistant Superintendent, 3rd grade.
Mr. M. J. Ople, Surveyor.
Sub-surveyor Hira Singh.


MAP
ILLUSTRATING THE
SURVEY OPERATIONS
IN
AFGHANISTAN
up to date, 1880.
NOTE. Survey in detail shown in Pink tint.
Geographical Reconnaissance supplemented by native information in Pink Lines.
AFGHANISTAN
BALUCHISTAN
BRITISH DOMINIONS
MOOLTAN
BHOWALPUR
JACOBABAD

to be done, both with the theodolite and plane-table, but for which Major Woodthorpe would not have been able to connect the triangulation of the Kuram Valley with that of the Logar and Kabul Valleys, which now together form a continuous series from Thull round *viâ* Kabul to Jellalabad.

145. At first, however, little could be done in the way of triangulation, and it was found necessary to base the topography on a traverse with a subtense theodolite from the Shuturgardan Pass *viâ* Kushi to Kabul, and even this was executed with considerable difficulty, owing to the length of the marches with the troops. Points determined by this traverse were every night plotted on a plane-table, and, with the aid of these, Captain Martin was enabled to make a fairly accurate preliminary reconnaissance of most of the Logar Valley on the scale of 1 inch to 4 miles.

146. The party arrived at Kabul on the 4th November 1879, and Captain T. H. Holdich, R.E., as the senior departmental officer, assumed charge of all further survey operations in Northern Afghanistan.

147. Mr. Ogle, of Major Woodthorpe's party, was detained in the Kuram Valley and accompanied General Tytler's column into the Zaimukht country, west of Kohat, where he secured topography to the extent of 880 square miles in country which was very little known. On completion of this work he proceeded to Kabul and took part in the survey under Captain Holdich.

148. On the occupation of Kabul and partial investment of Sherpur by Mahomed Jan's forces in December, the officers of the survey were temporarily transferred to the Field Engineer Department, and either assisted in the construction of defensive works, under Colonel Perkins, the Chief Engineer, or were placed on the personal staff of the Brigadiers and Generals Commanding. After the defeat of Mahomed Jan, Captain Holdich and Major Woodthorpe accompanied a brigade to the Koh Daman and succeeded in mapping a portion of the country on the $\frac{1}{4}$-inch scale and establishing two trigonometrical stations there.

149. Captain Holdich then joined General Bright's division in the Lughman Valley. Afterwards he accompanied General Sir F. Roberts on his march through the Logar Valley, taking advantage of this opportunity to make a leisurely re-survey of the valley on the $\frac{1}{2}$-inch scale. Major Woodthorpe at the same time considerably improved and extended the triangulation in this valley and fixed a number of points on the Altimor, Pughman, Deh-i-Sabz, and Karkatcha Ranges.

150. In April General Ross proceeded with a division through Maidan towards Ghazni to meet Sir Donald Stewart, then advancing from Kandahar. Major Woodthorpe accompanied this force, and was able to extend the triangulation and topography towards the head of the Logar River, the sources of which he states, have now been approximately fixed. He also ascended two points on the Pughman Range at elevations of 14,400 and 15,000 feet; but, unfortunately, the weather at this time had become hazy and he was unable to take observations to the distant peaks on the Hindu-Kush.

151. In June and July Captain Martin accompanied General C. Gough's brigade into the Koh-i-Daman and Kohistan, where he mapped 700 square miles on the $\frac{1}{2}$-inch scale and was successful in obtaining information regarding the courses of some of the rivers issuing from the Hindu-Kush and flowing through the Kabul Valley.

152. Mr. Claudius completed the topography of the country from Gundamak to Kabul on the $\frac{1}{2}$-inch scale, and under the escort and guidance of a friendly Khan of Tezin he mapped the important bit of country which borders the route across Lataband and the Haft-kotal Passes. This part of his work was executed at considerable personal risk, and he was badly frost-bitten in carrying it through.

153. Mr. W. W. McNair completed the survey of portions of the Asphan and Hisarak Valleys, west of Gundamak and of the Lughman Valley, both on the 1-inch scale, and subsequently he executed a large amount of excellent topography in the Logar Valley, on the $\frac{1}{2}$-inch scale.

154. In April two officers of the Royal Engineers, Lieutenant the Honourable M. G. Talbot and Lieutenant F. B. Longe, were attached to the Survey for duty, and did excellent work both as plane-tablers and in taking a share in the calculations for the general reduction of the observations.

155. The Native Sub-Surveyors were found particularly useful throughout the campaign from the fact of their being able to move about the country without much personal risk, even in disturbed portions of the country; their services were also largely utilised in pushing forward the Military Survey of the country around Kabul and Sherpur on the 4-inch scale.*

156. The total area mapped in Northern Afghanistan during the season is roughly estimated by Captain Holdich at 10,300 square miles, to which should be added 880 square miles in the Zaimukht country,—making in all 11,180 square miles, of which 64 square miles were done on the 4-inch scale, 1,276 on the 1-inch, and the remainder on the ½-inch and ¼-inch scales, in about equal proportions.

Notes by Captain Holdich on "the route to Kabul through the Lughman Valley," and an extract from Major Woodthorpe's report regarding the triangulation from the Shuturgardan Pass to Kabul, are given in the appendix attached to this report.

2.—The Operations in Southern Afghanistan.

157. On completing the survey of Pishin which is mentioned in paragraph 251 of the last report, Lieutenant Gore, R.E., received instructions from Lieutenant General Sir D. Stewart, K.C.B., to proceed to Kandahar *viâ* the Barghana route, which had not been previously surveyed. Accordingly he made a sketch of the route and the surrounding country, and amalgamated it with the previous surveys on the more direct routes to Kandahar. On arrival at Kandahar he was employed in making surveys of the surrounding country, including an area of 160 square miles in the fertile and well-cultivated country along the banks of the Argandab and Dori Rivers to their junction, which he mapped on the 1-inch scale. He also extended the triangulation towards Giriskh.

Personnel.

Lieutenant St. G. C. Gore, R.E., Assistant Superintendent, 3rd grade.
Sub-surveyors Atma Sing and Saidulla Khan.

158. Subsequently he accompained an expedition into the Argastan Valley which proceeded as far as the village of Badozai, about 8 miles between the point where the river issues from the hills; the Sundarzai villages were also visited, and the Tagak Kotal, through which an excellent road passes into the Tarnak Valley, was explored. This road was afterwards used by the 1st Brigade of the Ghazni column on their march towards Kabul. Lieutenant Gore states that

"of the three rivers forming the Argastan basin the Kushk-i-Rud is the smallest; its total length is about 50 miles. A fair body of water, however, comes down it, but it is very brackish and nasty to drink. Of the remaining two the Argastan has probably the larger basin, as a good deal of the drainage, which on old maps was shown as running into the Kadanai is now known to flow into the Argastan. The Lora River is said to take the overflow drainage of Lake Ab-i-Istada, and when the lake overflows the river water comes down very salt."

159. From Badozai the expedition turned to the south and marched skirting the main range of hills through the Kadanai plain until it reached Dabrai on the road from Quetta to Kandahar; a good reconnoissance of all this country was made and was based on trigonometrically fixed points. Subsequently, when General Stewart's force advanced from Kandahar on Kabul, *viâ* Ghazni, Lieutenant Gore accompanied it and was attached to the 1st Brigade, which commenced its march on the 30th March. The route taken led for two days up the Tarnak Valley, thence across the Tagak Pass, on the water-shed between the Tarnak and Argastan Rivers into the Khushk-i-Rud Valley, at the head of which it crossed an almost imperceptible water-shed and re-entered the Tarnak Valley, opposite to, but about 10 miles to the east of, Kalat-i-Ghilzai. From

* Captain Holdich reports as follows of the services of these men:—

"The Munshi carried on the mapping (on the large scale of four inches to the mile) of the Sherpur cantonments, and of the country immediately round it, during the actual progress of the investment, and thus really executed some most useful military work. He continued to work through the city and surrounding districts immediately the siege was raised, and before it would have been possible for any European to have been so employed. From a purely military point of view this part of his work was most important. He also undertook an exploration *viâ* the Kunar River into Kafiristan, travelling as a Native Doctor; there is every reason to suppose he could have succeeded in reaching Kafiristan (for he was never suspected at any time) but for an unfortunate rise of the Safis and Dehgans, which took place most unexpectedly. Returning to Kabul he was next employed in mapping a part of the district adjoining Kabul (stretching through the Chardeh plain to the district of Pughman) which had been entirely closed to European Officers, and which it appeared likely would altogether remain a blank. Here he succeeded perfectly, and finished a valuable bit of one inch topography extending to the main crest of the Pughman Range.

"Saidulla was further occupied for some time previous to the evacuation of Kabul in completing a portion of topography near the lane at Jellalabad, where it was advisable to employ Native rather than European agency."

this point onwards the route followed the foot of the Surgarh hills, which form the eastern flank of the Tarnak Valley, up to within a short distance of Shahjui, in latitude 32° 31′, where the 1st Brigade joined the main body of the army. The whole force then advanced into the valley of the Ghazni River, fought the battle of Ahmed-Khel on the 19th April and reached Ghazni two days afterwards.

160. Up to Shahjui Lieutenant Gore's work was based on trigonometrically fixed points, but beyond he had to rely on plane-table fixings and traversing until he reached the Wardak Valley above Ghazni and was able to effect a junction with the survey brought down by Major Woodthorpe from Kabul. While halting at Ghazni Lieutenant Gore made a large-scale sketch of the ground in the vicinity of the city, in which he was assisted by several officers of the force. He accompanied a small force sent to reconnoitre the Altamur Pass, and had hoped to reach the summit of the Pass and obtain a good view of the Zurmut Valley beyond, but this was found impracticable, as the hills were occupied in considerable force by the enemy. On reaching Kabul Lieutenant Gore was permitted by Sir Donald Stewart to return to India in order to complete his mapping.

161. Major E. P. Leach, V.C., had proceeded to Europe on sick leave in consequence of a wound received during the first campaign. On his return he was sent to Kandahar to be available—in communication with Colonel St. John, R.E., the Political Officer—for any survey work which might be wanted. Few opportunities were presented for survey operations, but Major Leach succeeded in reconnoitering a portion of the Argandab Valley, and in extending the previous year's survey of the Khakrez Valley eastwards for some distance; he also fixed a number of the peaks on the water-shed between the Argandab and the upper waters of the Tirin Valley, and obtained some valuable information concerning the passes into and across the Hazara country. Unfortunately—

"The whole of this material, together with a series of valuable notes concerning the Hazara tribes and country, was lost during the retreat from Maiwand and during the subsequent evacuation of the Kandahar cantonment."

The survey portion has, however, since been replaced during an exploration made by Lieutenant the Honourable M. G. Talbot, R.E., and Lieutenant F. B. Longe, R.E., and Major Leach has drawn up from recollection and some brief notes which he had saved, a *résumé* of the information which he had collected of the Hazara country and people, and has embodied the results on a sketch map which, he says,

"is so far valuable that it gives an idea of the general lie of a country which is at present a perfect blank and the relative positions *inter se* of the more important tribal divisions."

162. At the beginning of June, Major Leach sketched a portion of the Maiwand District, which lies at the foot of the Shah Maksúd Range and is intermediate between the Garmao and Khakrez Valleys, in continuation of the previous survey of the Khakrez Valley. He subsequently accompanied General Burrows' force to Girishk and did good service on the staff during the disastrous battle of Maiwand and retreat to Kandahar. He was then appointed Brigade Major of Engineers and served in that capacity throughout the defence of Kandahar and in the subsequent battle of Kandahar, when the enemy under Ayūb Khan were defeated by the British troops under General Sir F. Roberts. For some time after these events further survey operations at a distance from Kandahar were impracticable; meanwhile a survey of the city and its environs was commenced on the scale of 6 inches to the mile.

163. Lieutenant the Honourable M. G. Talbot, R.E., and Lieutenant Longe, R.E., accompanied General Sir F. Roberts in his memorable march from Kabul to Kandahar; they were present at the battle of Kandahar, and have since been employed in such survey operations as the movements of the troops enabled them to undertake.

3.—The Operations in Beluchistan.

164. In September 1879, as there was no immediate prospect of more survey being undertaken in Southern Afghanistan, Major Beavan was directed to proceed from Kandahar to Quetta to survey the country between and around

Personnel.

Major R. Beavan, S.C., Assistant Superintendent.
Mr. J. T. U. Coxen, Assistant Surveyor 1st grade.
„ H. Corkery „ „ 3rd „

Quetta and Sibi as opportunities offered. On arrival at Quetta he found that an expedition was about to start under the Political Officer, Captain Showers, to explore the route to Sibi, *viâ* the Hamra Pass. Furnished with the approximate positions of several prominent peaks which had been fixed by previous triangulation, he proceeded *viâ* Astangi through the Tiri defile to Sangan, whence he accompanied Sir R. Sandeman to Sibi *viâ* Harnai, leaving Captain Showers to explore the country to the north for a direct road to Sharigh and Dargi.

165. While at Harnai he was able to visit the hill of Torgarh, about six miles to the south, from which a good view was obtained of all the country towards Sangan and Nari.

Afterwards he went to Khost in the Dargi Valley, where he met Sir R. Temple, Governor of Bombay, and accompanied him to Thal, from which place he subsequently accompanied military expeditions towards Chotiali and to Baghao and Smalan on the north-east.

166. Major Beavan had considerable difficulties to contend against, as the disturbed state of the country prevented him from deviating to any distance from the routes followed by the troops; but he succeeded in making a rough reconnaissance, on the scale of 1 inch = 4 miles, of about 2,500 square miles between the parallels of 29° 15′ and 30° 20′ and the meridians of 67° 10′ and 68° 50′ extending from Quetta to Thal-Chotiali and down to Sibi, which was of much use afterwards to the engineers employed in laying out the new line of railway. He also completed some triangulation near Sibi and Dadur.

167. The assistant surveyors (Messrs. Coxen and Corkery*) completed a survey of 1,500 square miles around Sibi, Mitri and Dadur, in detail, on the scale of 1 inch = 2 miles.

168. Major Beavan proceeded in April to the Head-Quarters at Mussoorie, with his field maps and original records and observations, with a view to completing the calculations and preparing the fair maps. This work done, he returned to Sibi in July, to resume field operations whenever and wherever it might be found practicable to operate in the hill tracts of Beluchistan lying on the northern frontier of the Province of Sind.

4.—On the general organization of Survey Operations with an Army in the Field.

169. In the General Report for last year, a special report on the experience gained regarding the sufficiency of the general organization of the survey operations during the campaign in Afghanistan was made, under the instructions from the Secretary of State for India prescribing that all experience on the work and organization of the several departments engaged, directly or indirectly, on the conduct of the campaign, should be reported on and recorded for future guidance.

170. During the present year a committee was assembled at Kabul, under the orders of General Sir Donald Stewart, G.C.B., for the purpose of considering the equipment necessary for a survey party in the field. The committee was composed of Lieutenant Colonel Stewart, of the Guide Corps, as president, and Major Woodthorpe and Captain Holdich, of the Survey Department, as members. Their recommendations were as follows:—

1. A survey party should consist of one officer (who should be both accustomed to triangulate and to use the plane-table) and of two assistants (one of whom should be competent to triangulate) as topographers for each column operating on an independent line in a country where no survey has hitherto been made.

The native establishment for a party of this size should be as follows:—

For 1 officer 7 followers
„ 2 officers 10 „
} inclusive of interpreters and permanent guides.

The addition of native sub-surveyors must depend entirely on the nature of the country under survey, but when they are employed, extra public followers, at the rate of at least one per sub-surveyor, will be necessary.

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* Major Beavan reports that "both Messrs. Coxen and Corkery have undergone a great amount of very hard work and had difficulties and privations to encounter. The work they have turned out has been carefully done, and they have succeeded in dealing with the Pathan and Beluchi inhabitants of the country without raising opposition or provoking complaints, which I consider highly creditable to them."

2. The instruments for the equipment of such a party will be as follows:—

1 six-inch subtense theodolite with full vertical circle and tripod stand.
5 plane-tables, *viz.*, one for the officer in charge and two for each assistant.

The two for each assistant should be interchangeable on one stand and should be of different sizes and portability. The committee are of opinion that the plain deal table, 30″ × 26″, has, on the whole, been found to be of the greatest use on account of its superior size and stability. It can be slung with its stand on a mule or pony without difficulty and can be used with cavalry. But each assistant should also be provided with a lighter, smaller, and more portable table, which can be conveniently slung on a man's back; a really portable table of this sort has yet to be devised, as also the best kind of stand.

Each officer or assistant should also be provided with the following minor instruments and books, *viz.*:—

2 trough needles, 1 sight-rule, 1 telescope or binocular, 1 aneroid barometer, 1 prismatic compass and stand, 3 thermometers for determining the boiling point of water, ordinary air thermometer, 1 Gunter scale, 1 beam compass, 1 small box instruments, 1 Shortrede's log tables, 1 Chambers's log tables, 1 auxiliary tables for facilitating the computations of the Great Trigonometrical Survey.

The Officer in charge should carry in addition—

1 Abney's level, 1 set scales, 1 maximum and minimum thermometer, 1 nautical almanac, 1 prismatic subtense instrument, 1 parallel ruler, 1 pantagraph, 1 manual of surveying, 2 sets measuring tapes (steel), 1 perambulator, lamps for observing, 1-6″ heliotrope, 1 chronometer watch, 1 portable sun-dial, spare compass and drawing pens.

3. *Stationery.*—The ordinary forms in use should be indented for before starting, in quantities suited to the nature of the work likely to be undertaken, but not more than three months' supply either of forms or stationery need ever be carried.

4. Office tentage and baggage allowance should be on the same scale as that of the senior Quarter Master General with the division.

5. In addition to the usual personal baggage scale, the following will be required for the Head-Quarters camp—

Office tent	150 lbs.
„ table	20 „
Stationery and small instrument .	160 „
Maps and Data	50 „

For public followers 1 sepoy's pâl, holding 17 persons, or its equivalent in smaller tents.

171. These recommendations were made on the following assumptions regarding the nature and extent of the work to be undertaken by the Survey officers:—

A.—That a large extent of country, embracing several thousand square miles, may be either actually visited or sketched from a distance, during the course of a campaign.

B.—That every surveyor should be equipped to act independently, if necessary.

C.—That there may be no opportunities of visiting any portion of the ground twice, and therefore that all surveying must be done *pari passu* with the more or less rapid movements of troops along the main lines of communication.

D.—That maps are to be compiled and traced in the field, so that all the work of the Survey can be put into the hands of the Generals concerned as speedily as possible.

E.—That the topographical operations are not to consist merely of surveys of the lines of route, but are to embrace as much as possible of the surrounding country, and must therefore be executed on a trigonometrical basis; consequently, that the surveyors must always work together in pairs, one doing the triangulation, the other the topographical sketching; for, when the troops are marching rapidly, it is impossible for any single man to do both, and each is required to supplement the other.

F.—That the Survey office with the Army will be the general depôt for all maps of the country which may be published by the Surveyor General's Department and be supplied for distribution as required.

G.—That the sanctioned allowance of baggage and equipment for every officer in the field who is employed in transport, commissariat or any other duties which oblige him to carry his own camp equipage and make it impossible for him to join a mess, is 400 lbs.

172. The recommendations were obviously much influenced by the circumstance that the military occupation of Afghanistan was long protracted, so that the whole of the equipment specified by the committee had been found to be necessary. It will be obvious, however, that much valuable work of military survey and reconnaissance may be done by officers who are equipped more lightly, with instruments fewer in number and of a smaller size; and indeed that when a force has to march with great rapidity through an enemy's country, as in General Sir F. Roberts's march from Kabul to Kandahar, it would be absolutely necessary to restrict the equipment of each Survey officer to what might be readily carried about by himself and one or two attendants.

173. It will be obvious that the nature of the equipment must be materially influenced by the nature of the duty which the officer has to perform,—that is to say, by the consideration whether he is expected to make a general geographical survey of as much as can be seen of the country, or a detailed topographical survey of the principal military roads and lines of communication and the ground in their immediate neighbourhood. Both surveys may be invaluable to the officers commanding the forces, but it is scarcely possible for both to be performed satisfactorily by the same individuals and the same processes of operation. The general geographical survey of the country is not required to give much minute detail, but it must be conducted with some precision in order that what it does give may be accurate; on the other hand, the topographical sketches and reconnaissances are required to give full details of the configuration of the ground on both sides of the principal military lines of communication, and more particularly to show all the hills by which the roads are commanded; for them, however, fullness of detail is of infinitely greater importance than precision of execution. The geographical survey is mostly of value for rapid strategical movements over a large area of country, while the topographical is mostly of value to aid a general officer in determining the best disposition of his troops in action or wherever liable to be attacked by an enemy. The geographical survey must, necessarily, be made on a much smaller scale than the military topographical sketches, and it would be of very little use wherever minute detail is required; but, on the other hand, the topographical sketches would by no means suffice of themselves for the construction of a reasonably accurate map of the country.

174. In the first Afghan War a large amount of route surveying was executed: it was mostly done on the scale of 1 inch = 1 mile, and some of it appears to have been of very good quality; but few, if any, attempts were made to carry on a general geographical survey of the country *pari passu* with the military route surveys. Thus, when the latter came to be combined together, large gaps were found to exist in our knowledge of the country; sufficient data were not even forthcoming for an accurate combination of the work which had been done, the result being that in the maps of Afghanistan, which were executed on the basis of the route surveys, the cities of Kabul and Kandahar are shown respectively as 7 and 15 miles west of their true positions relatively to places in the same parallels of latitude on the British frontier.

175. It was the chief duty of the Officers of the Survey Department who served in the last Afghan War to endeavour to obtain as much information as possible of the country at large, and not merely to operate on the military lines of communication. For this purpose they were directed to make general maps of the country—on scales of $\frac{1}{2}$ an inch or $\frac{1}{4}$ of an inch to the mile, as might be most suitable in each case—by the method of plane-tabling on a trigonometrical basis; also to carry route surveys, on the 1-inch scale, with the most suitable instruments available, over the principal roads traversed by the troops. They were, of course, expected to make themselves generally useful whenever occasions might arise for their employment on other duties; but it was contemplated that whatever work of military reconnaissance and sketching on scales larger than that of 1-inch to the mile might be required, would be done by some of the numerous field engineers and staff officers attached to the army, who were more or less skilled in the performance of such duties. Thus, it has resulted that the bulk of their work is on the $\frac{1}{4}$ and $\frac{1}{2}$-inch scales; their route-surveying on the 1-inch scale became generally merged into their smaller scale maps; they surveyed Kandahar and the surrounding country within a radius of ten miles on the 1-inch scale, and Kabul and its environs on the 4-inch scale; but the bulk of the work of military reconnaissance was done chiefly on the 6-inch scale, by field engineers and staff officers who were attached to the several divisions of the army; regimental officers were also largely employed in making field sketches and reports.

176. The Surveyor General is of opinion that this separation of the work of precise military survey from that of approximate military reconnaissance, the former being allotted to the professional military surveyor, the latter to the staff officer or field engineer, is a judicious arrangement which deserves official recognition and should be laid down as a rule for future guidance. It was found to work well on the whole during the late campaign, though it was not formally introduced, but merely came to be adopted in course of time as the

most appropriate way of employing the several officers whose services were available for the various kinds of work to be performed. Had the principle been generally adopted from the outset, even better results might have been obtained, and there are many excellent reasons for its adoption in future campaigns in India. The survey of a large extent of country, more particularly during hurried movements of troops, is one which is obviously more likely to be performed satisfactorily by a military officer who had been constantly practising the duties of a professional surveyor, than by a field engineer or staff officer, who has been as constantly employed on other duties. On the other hand, in the work of military reconnaissance, the professional surveyor may, from want of military training, be often at a disadvantage as compared with the staff officer, and may not succeed as well in obtaining local information on various points affecting the movements of the troops, which is usually of great value to a general officer, and may even be of more importance than the topographical sketches; this work should, therefore, be performed whenever possible by staff or regimental officers, rather than professional surveyors. Such division of labour has the further advantage of employing each officer on that work in the success of which he is most immediately interested.

177. The recent publication of the report of the Committee appointed by the Secretary of State for War to report on the System of Instruction for Military Sketching and Surveying, in the British Army, affords the Surveyor General an opportunity of offering suggestions on the recommendations of the Committee on two points of importance which may well receive further consideration. *First*, the "re-introduction of the plane-table in its simplest form" as an instrument of survey; and, *secondly*, the "substitution of the system of showing hill features by shading in mezzotint, with stump and powdered chalk, or lead from a pencil, for the one now in force of indicating them by horizontal hachures."

178. The Committee recommend the re-introduction of the plane-table on the following grounds: that it is "the principal instrument used in India for surveying;" that it "can be now made as light as the sketching case, which every man working with a prismatic compass usually carries;" and that it may be employed in countries, such as Southern Africa, "where the prismatic compass was very unreliable, and in some cases almost useless, owing to the powerful local attraction in the ground." Now, it is impossible that plane-tables of the same form and design can be made to subserve the two conditions of portability and independency of the magnetic compass. This may be readily inferred from the following description of the plane-table which is used in the Indian Survey Department.

179. The plane-table is ordinarily 30 inches long by 24 broad and $\frac{3}{4}$ of an inch thick, and is made of the lightest wood procurable, well seasoned and not liable to warp to an extent that will sensibly distort the plane of the table. It is usually supplied with a strong and well-braced tripod stand, on which it can be set up and clamped very firmly; folding tripods with tightening screws are also used occasionally and are about two-thirds of the weight, 12 lbs., of the braced tripod. The plane-table is also supplied with an ebony sight-rule, which is usually about 27 inches in length by 2 inches in breadth, and carries brass sight vanes about 4 inches high at each end, by means of which the rule can be truly directed on any surrounding object. The lower surface of the rule and the upper surface of the table being both truly planed—so that the rule will rest evenly on all parts of the table over which it may be brought—the two together constitute a surveying instrument which may be employed independently of any instrument for measuring angles, such as a theodolite, sextant, or magnetic compass, provided that the table when set up is firmly clamped to its stand, and is not liable to be thrown out of position by the lightness or weakness of its supports. But if the plane-table is to take the place of all other instruments, and be employed in localities where local magnetic attraction renders the prismatic compass useless, it must be true in surface and free from shake: thus, it cannot be made materially lighter than the ordinary Indian plane-table, which weighs about 25 lbs. with stand and sight-rule complete, and cannot well be carried about by less than two persons, and is certainly a very awkward instrument to take about on horseback.

180. It would appear, therefore, that the officers who have reported to the

Committee in commendation of the plane-table on the grounds that "the table itself can be now made as light as the sketching case which every man working with a prismatic compass usually carries; and the legs, which are separate, can be made so as not to be much more inconvenient to carry than a large stick," must have been thinking, not of a plane-table forming a complete survey instrument in itself as above described, but of one requiring to be used in combination with a magnetic needle to govern the setting-up of the table, and, therefore, as useless as the prismatic compass would be in localities influenced by local attraction. Still, such an instrument would be very serviceable in furnishing a small table, on which the topographer can work in much greater comfort and ease, and therefore with greater rapidity, than on the ordinary sketching block.

181. The magnetic needle is usually of so great assistance in enabling a plane-table to be speedily adjusted to the true meridian that a long trough needle is invariably supplied to every plane-tabler on the Indian Survey; the table is first brought into position with the aid of the needle, and finally adjusted by the sight-rule on surrounding fixed objects, as the magnetic position cannot be relied on. But firmness and trueness of table, and accuracy of sight-rule, are essentially necessary to obtain good results when the plane-table is employed, as usual, independently of all other angle-measuring instruments, after once it has been brought into position.

182. On the other hand, a much smaller table than the Indian plane-table, mounted on a folding tripod stand, such as is usually supplied for the support of a prismatic compass, may be used in combination with a small theodolite, with entire satisfaction as regards accuracy of results, though with somewhat more of labour than in the case of the plane-table pure and simple; for the angles must be measured with the theodolite and laid off with a protractor. But the operations would be independent of the magnetic needle, and unaffected by any accidental displacement of the table. Probably the best and most convenient of theodolites to employ for extended operations in which more or less precision is necessary would be Casella's little altazimuths, with 3-inch horizontal and vertical circles divided to read minutes, telescopic power $5\frac{1}{2}$, weight in box $4\frac{1}{2}$ lbs., weight of stand $3\frac{1}{2}$ lbs. For ordinary topographical reconnaissance it would suffice to employ a prismatic compass, which might be rested on the table itself; then the extra weight to be carried about, as compared with that of a hand-held prismatic compass and sketching block, would be merely the excess of the weight of the table over that of the block, *plus* the weight of the folding tripod stand, all which need not be more than 5 lbs.

183. The question of the propriety of employing the plane-table, pure and simple, is much influenced by the scale on which the survey or reconnaissance is to be made. The instrument is specially valuable for determining the positions of all surrounding points which are visible at two or more fixed stations, or for determining the position of a station at which the table is set up, by interpolation from surrounding points which have already been fixed by triangulation. The plane-tabling in Northern Afghanistan was at the outset entirely based on points which had been fixed on the summits of the great mountain ranges in previous years, by observations from the frontier stations of the Indian triangulation, and of which the positions are given in Synoptical Volume I of the results of the operations of the Great Trigonometrical Survey of India. Many of these points were 30 to 60 miles distant from the plane-tabler: thus, as the size of the tables was 30 by 24 inches, a larger scale than $\frac{1}{4}$ of an inch to the mile could not be used without discarding several of the more distant points, which might often be of much service to the plane-tabler in interpolating his position.

184. The scales recommended by the War Office Committee are 1 to 2 inches to the mile for roads and rivers, and 6 inches for positions and camps. The largest of these scales was adopted in Afghanistan for the Kuram Valley and the road from thence to Kabul *viâ* the Shutargardan Pass, for the road through the passes between Kabul and Jellalabad, and for the Khyber Pass. Obviously, where so large a scale is used, the work must necessarily be of the nature of reconnaissance rather than exact survey. When done on a sketching block, a large number of sheets of paper must be used, and this is very troublesome at the time and afterwards in joining the sheets together. For reconnaissance on

a large scale, regular plane-tabling is not suited, as a sufficiency of well-marked points for the plane-tabler to work on would probably not fall within the limits of the paper. But when working with a small table and a prismatic compass, in the manner indicated in paragraph 182, paper mounted on cloth in sheets extending considerably beyond the limits of the table, may be used with advantage, with the aid of a few drawing brads to pin down the sheet on the board at the part which is wanted. This method was practised during the last three years of the Trans-Indus Survey of 1849-54, and was found most convenient; the paper, mounted on brown holland, was obtained in rolls a yard wide, from which any desired length, usually 1½ yards, might be cut; the table was only 1 foot square, and was mounted on the stand of a prismatic compass; the angles were measured with a 5-inch theodolite, the smallest available at the time, and were plotted with a protractor and marquoise scales; the scale of the survey was 1 inch to the mile; the paper was pinned down to the board with brads when in use, and rolled up and kept in a wax-cloth case when not in use. The whole of the instruments might be carried about by two persons, whether on foot or horseback, without difficulty. For ordinary military reconnaissance a roll of paper mounted on cloth, 12 to 18 inches wide and 24 to 30 inches long, would probably suffice, and a wax-cloth cover would be ample protection for it while being carried about; the corresponding instrumental equipment would be a light table, 10 to 12 inches square, mounted on a folding tripod stand; a prismatic compass, a protractor, and a scale with folding sights which might be used on occasion as a sight-rule.

185. As regards the substitution of shading in mezzotint for the present system of horizontal hachures, in order to show hill features, there can be no question but that maps so produced could be drawn with greater rapidity and would, as a rule, be clearer and better understood. When only a *single* copy of a sketch or map is wanted, nothing better can be desired. But if several copies are wanted as speedily as possible, as frequently happens, then the map should be drawn with a view to adapting it for the only process which is at present known for obtaining speedy reproduction and multiplication, *viz.*, photographic transfer to stone or zinc. This process enables pen and ink drawing, however elaborate and complicated, to be reproduced and multiplied satisfactorily and with great rapidity; but it cannot reproduce mezzotint. Thus an original drawing in mezzotint must always be redrawn by hand, on transfer paper or stone, before it can be multiplied, and this is usually a slow and laborious process, requiring much more time than direct reproduction by photography; consequently, all maps and sketches which are required to be speedily multiplied should be drawn in pen and ink. As regards reproduction it is immaterial whether the hachuring of the hill features is drawn vertically or horizontally; but for clearness and general legibility vertical hachures are usually preferable in small-scale maps, and horizontal in large-scale ones.

186. The speedy reproduction and multiplication by this Department of the maps and sketches which were received from Afghanistan, directly or through the Quarter Master General's, the Foreign and other offices, constitutes a feature of much importance as regards the connection of the Survey Department with the general business of the campaign. Up to the end of 1880 over 400 maps and sketches, in sections of various sizes ranging from "double elephant" down to "foolscap," obtained from all quarters, were reproduced by photozincography; upwards of 50,000 prints were taken, giving an average of about 125 copies for each subject: the average time which elapsed between the receipt of an original map or sketch in the photozincographic office and the issue of the requisite number of copies from that to the despatch office, was 5 days for each subject, including Sundays and holidays and the time spent in examining the proofs and correcting the zinc plates; ordinarily when the original was clearly drawn, so that the plates did not require correction, 200 copies could be supplied without much difficulty on the third day after its receipt in the photographic office; and in not a few cases copies were despatched to the Generals and Staff Officers in Afghanistan by the third day.

187. In some instances the prints were rough and coarse, but this was because the originals were in the same condition. Photozincography cannot do more than produce a facsimile of any subject; it cannot improve on, and

indeed is liable to produce something slightly less good than, the original. But a map, however rough and coarse, may, if supplied *instanter*, be often of far more value than an elaborately finished map supplied some time afterwards. Thus the general principle was followed, of furnishing the Government Offices, the Army Head Quarters and the Officers commanding the troops in Afghanistan, with facsimiles of all maps and sketches precisely as received, so that the persons most interested might be placed as speedily as possible in possession of all the latest information available. New maps were compiled in the Surveyor General's Offices as soon as possible after any new information was received; and new editions of previous maps were published from time to time as rapidly as was practicable. But the labour of re-drawing and compiling was great; and a long period was consequently liable to elapse between the publication of the facsimiles of the primary materials, and the publication of the maps into which these materials were incorporated. Thus, the speedy publication of the originals was a desideratum of great importance, and the Survey Department may claim credit for the manner in which that want has been supplied.

188. It may be here stated that most of the maps supplied for the use of the officers in Afghanistan were printed on calico instead of paper. Prints on calico are nearly as sharp and clear as on the best paper; the cloth is lighter, more readily folded, much more convenient to carry about, and far less liable to be torn and injured, than any of the various kinds of paper on which maps are usually printed. On the other hand, they are not so well suited for the insertion of correction and additional matter. Thus, a few prints on paper were also furnished to supplement the prints on cloth.

XXV.—TRANS-FRONTIER EXPLORATIONS.

Irrawaddy River Exploration.

189. In the early part of 1879, Captain J. E. Sandeman, Deputy Superintendent, in charge of the Cadastral Survey in the Hanthawaddy District, British Burma, was requested, with the sanction of the Chief Commissioner, to train a native of Burma, with a view to his being employed in exploring the upper course of the Irrawaddy River, beyond Bamo. Towards the end of the year, this man had acquired a sufficient knowledge of his duties to be started on a preliminary exploration.

190. A full account of his journey and adventures will be found in Captain Sandeman's report in the appendix. Here, therefore, it is unnecessary to say more than that he started by steamer from Rangoon with two companions of his own selection, and arrived at Bamo early in November 1879. Thence the party went up the river in boats, first to the village of Haw-ka in latitude 25° 6′, and then to Ka-cho, once an important city, in latitude 25° 20′ at an elevation of about 1,000 feet above the sea. Thence he proceeded by land, pacing distances and taking bearings, up to Mogoung-poon Maing-koung in latitude 26° 8′, at which place the exploration terminated.

191. At the village of Maingna, about 16 miles north of Ka-cho, the Burmese frontier was reached. The country beyond is inhabited by Kachins or Kansa-Kachins, among whom no Shans reside, and the people pay no tribute to Burma. Two days afterwards the village of Pouk-san-poon was reached, whence a view was obtained of the junction of the eastern and western branches of the Irrawaddy River, about 5 miles to the north-west. The western branch (called the Malee-ka) had previously been noticed to be considerably swollen and about 500 paces wide, while the eastern branch (called Meh-ka), which was now reached, was found to be low and flowing in a stream about 100 paces wide, down rapids and over large rocks. The people of the country stated that the great increase in the waters of the western branch was due to the melting of the snow at its sources, and there can be little doubt that the western branch is the larger of the two and rises in higher ranges.

192. Such information as could be obtained from the natives of the country was to the effect that the eastern branch has two principal affluents, one flowing from the east, which is believed to have its source in the Naungsa Lake, and the other from the north, which is said to rise in the hills at six days'

Some Sources of the River Irrawaddy, above Bamo.

journey from Mo-goung-poon, the days' journey being reckoned at eight to ten miles. Of the western branch it was stated that its sources are in the "Kantee country," at a distance of about 23 days' journey from Ka-cho. Thus it is highly probable that this is the branch of the river reached by Wilcox in his journey from Assam in 1827, which is described in Volume XVII of the Researches of the Asiatic Society of Bengal, Calcutta, 1832. The explorers' "Kantee" is obviously identical with Wilcox's "Khanti."

193. In the accompanying map of Some Sources of the River Irrawaddy above Bamo, the country below the parallel of 26° 30′ is taken from a map by Captain Sandeman, which was compiled solely from the explorers' field books, and in which the adopted origin is the position of Bamo—latitude 24° 16′, longitude 96° 53′ 47″—which was determined in 1868 by Captain Bowers and first employed in the map illustrating Dr. Anderson's report on the expedition to Western Yunan (Calcutta, 1871). The country north of the parallel of 27° is taken from Wilcox's map of his surveys and routes in Upper Assam and Burma during 1825 to 1828. A portion of a smaller-scale map by Father Desgodins to illustrate a paper on the eastern frontier of Thibet, which he has recently presented to the Asiatic Society of Bengal, is also given for comparison. It will be seen that the information obtained from these three independent sources is fairly accordant, though greater exactitude is still a desideratum of importance for correct geography. The adopted longitude of Bamo, on which the lower portion of the map is based, is about 4 miles to the west of that employed by Colonel Yule in the map published in his "Narrative of the Mission to the Court of Ava in 1855," and 10 miles to the west of that assigned by Wilcox in 1828, not from actual survey but from such information of itineraries as was then available. The new value was determined by Captain Bowers, of the mercantile Marine Service, when he visited Bamo as one of the members of the Yunan expedition; Dr. Anderson states that Captain Bowers had much previous experience in astronomical observations, was a very careful observer, and devoted many a night to the object of determining the positions of Bamo. Wilcox's longitudes in Assam, on which the upper portion of the map is based, have been very closely corroborated by recent operations of the Great Trigonometrical Survey; but Wilcox does not appear to have been able to take any observations for longitude when he reached the Irrawaddy River; thus his map of the country between Assam and the Irrawaddy rests on a route survey, which was executed under considerable difficulties and was checked only by observations for latitude. There may possibly be a little too much easting in the upper and too much westing in the lower portion of the accompanying map; but under existing circumstances it is preferable to show the results of each survey independently of the other, and to postpone any attempt to combine the two until a survey has been made of the as yet unknown course of the main branch of the Irrawaddy, between Wilcox's Moong-Khanti and the explorers' junction of the Malee-ka and Meh-ka Rivers.

XXVI.—SURVEYS AROUND GILGIT.

194. Colonel Tanner was returning to recess quarters to bring up his mapping and calculations of work done during the summer of 1880, and had reached Lahore, when he was ordered back to Sirinagar and placed in command of a body of troops in the service of the Maharajah of Kashmir, under instructions to proceed to Gilgit for the relief of Major Biddulph, the Political Officer, whose safety had been imperilled by a general rising of the surrounding tribes with the avowed intention of subverting the authority of the Maharajah in those regions. This has prevented him from completing his mapping or doing more than submit a brief report of his survey operations. He has, however, intimated that, with the assistance of his native Surveyor, Ahmed Ali, he made a small-scale geographical survey of an area of about 2,000 square miles during the last field season, and that the limits of the Gilgit map now extended as far south-east as Astor, northwards to the great range which separates little Guhjal from Gilgit, southwards to Chilas, and westwards to the mouth of the Wurshigum River at the entrance to the Yasin Valley. Several of the spurs which run

down from the range west of the Khagan Valley to the Indus have been fixed, but the names of the valleys between them have not been ascertained. The positions of several far distant peaks on the Hindu-Kush range have been fixed, and among them the summit of the notable Tirich Mir mountain, first brought to notice by Major Biddulph, which lies to the north of Chitral, and rises to a height of between 24,000 and 25,000 feet as approximately deduced by Colonel Tanner from his preliminary calculations.

XXVII.—THE TIDAL OPERATIONS.

195. These operations are progressing very satisfactorily, in accordance with the programme prescribed by the Government of India, for obtaining a systematic record of tidal phenomena on Indian coasts, which is given in section XI of the General Report on the Operations of the Great Trigonometrical Survey for 1876-77. When the last annual report was submitted, self-registering tidal instruments had been set up and were in operation at eight ports,—*viz.*, Aden, Kurrachee, Bombay, Karwar, Beypore, Paumben, Madras and Vizagapatam; these instruments have been in operation throughout the year now under review; similar instruments have also been set up and are now operating at six additional places,—*viz.*, False Point, Rangoon, Elephant Point, Amherst, Moulmein and Port Blair; self-registering anemometers and aneroid barometers and verificatory mercurial barometers have been erected at all the tidal stations with the exception of Kurrachee, Bombay and Madras, at the first of which they shortly will be erected, but not at the two last, where there are meteorological observatories from which all necessary information for the reduction of the tidal observations may be readily obtained.

Personnel.
Captain A. W. Baird, R.E., Assistant Superintendent 1st grade.
Mr. W. G. Beverley, Officiating Assistant Superintendent 2nd grade.
Mr. T. H. Rendell, Assistant Surveyor 1st grade.
Mr. E. J. Connor, Assistant Surveyor 1st grade.
Dhondu Vinayek, Sub-Surveyor.

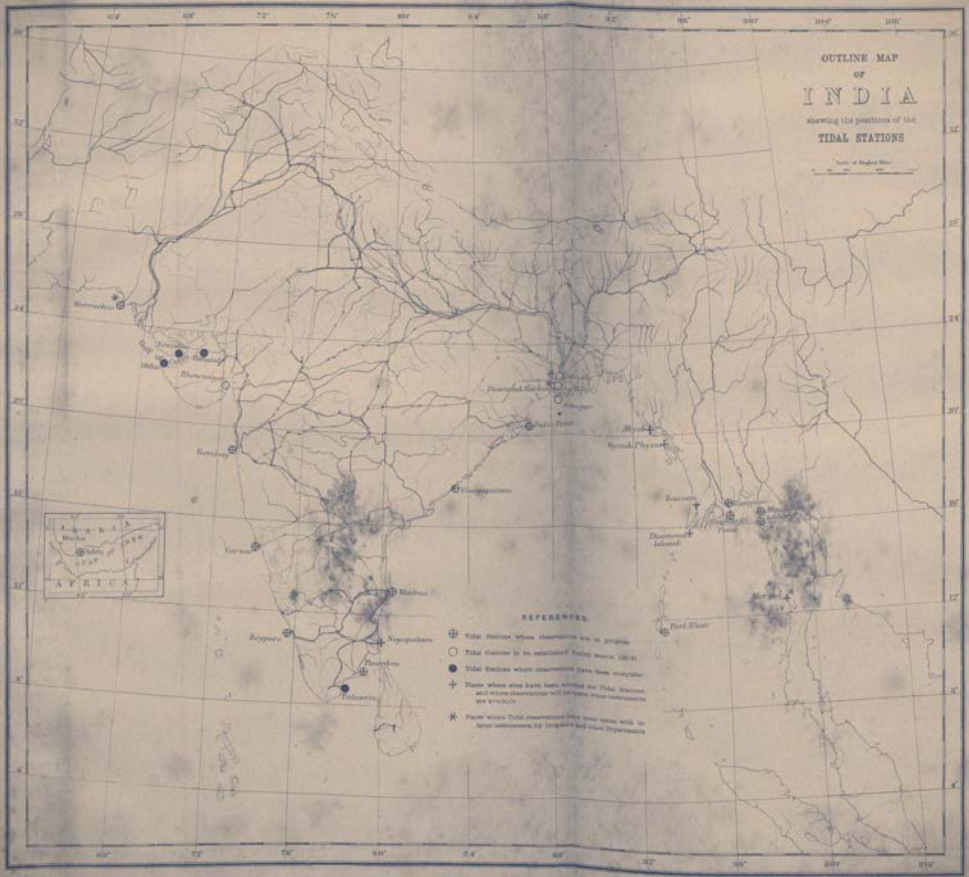
196. At Aden the new tide-gauge of the standard pattern which was erected in March 1879, in place of the small one previously set up by the port authorities, has been working very satisfactorily, and there has been no interruption whatever in the registration of the tidal curves. The anemometer and aneroid barometer have also been working satisfactorily. Daily reports have been received in weekly batches by the mail steamers, and an inspection was made by Mr. Rendell in January 1880. The Port Officer, Mr. Thynne, has rendered constant and valuable assistance. Two years' observations have been reduced by Captain Baird, and they form the basis of the Tide Tables for 1881, which are now being published.

197. At Kurrachee the old small-scale tide-gauge, set up many years ago for Mr. Parker, has been employed throughout the year, because a press of work, caused by the war in Afghanistan, prevented the port officers from setting up the new instruments, though a complete set had been supplied by the middle of the year. An inspection was made by Captain Baird in November 1879; some six years' observations with the old gauge then remained unreduced and were handed over to Captain Baird, by whom they have now been finally brought up and analysed: the results are given in the appendix.

198. At Bombay the tide-gauge on the Apollo Bunder has continued to work most satisfactorily: it has been inspected on two occasions by Captain Baird and Mr. Rendell. Another tide-gauge is in readiness to be set up near the entrance to the Prince's Dock.

199. At Karwar the action of the tide-gauge was satisfactory, being continuous with a few trifling exceptions. The anemometer also worked well throughout, but not the aneroid barometer. Inspections were made on three separate occasions, on the last of which the whole of the instruments were taken to pieces and cleaned, and the driving-clocks were also cleaned.

200. At Beypore the observations have been registered very satisfactorily, the aneroid being the only instrument which has given trouble. Inspections were made on three separate occasions during the course of the year. The arrangements for connecting the well of the tide-gauge with the sea had to be modified on one occasion in order to prevent the piping from becoming choked



Lithographed at the Surveyor General's Office, Calcutta, November 1880.

by mud; but this was accomplished without any sensible interruption in the continuity of the register.

201. At Paumben continuous results have been obtained from the tide-gauge, though an accident happened which might have destroyed the value of the register but for the timely and judicious assistance rendered by the Port Officer, Mr. Baker. The band connecting the float with the registering apparatus parted, just above the float; a re-connection was immediately made, but the relation of the pencil on the barrel to the zero of the gauge was necessarily altered in so doing; and the new registration would have been worthless without a determination of the amount of the alteration. Mr. Baker promptly came to the rescue and made the necessary measurements, on being telegraphed to by Captain Baird to do so. The aneroid barometer has worked well, but not so the anemometer, the clock of which has stopped several times. Paumben is difficult of access, but Mr. Baker being resident on the spot, it has not been necessary to make more than one inspection of the observatory during the year.

202. At Madras the communication between the tidal observatory at the shore end of the pier and the sea was destroyed by a cyclone in May 1879; an attempt to restore the communication, by means of a syphon tube laid under the roadway of the pier above the action surf, failed because of the difficulty of expelling the air out of the great length, nearly 600 feet of horizontal tubing. It was obvious that no permanent observatory could be erected until the completion of the breakwater which is now under construction. Meanwhile, a temporary station has been erected at the head of the pier, with the special sanction of His Grace the Duke of Buckingham, on the condition that the space occupied should be the minimum possible and that the observatory should not interfere with the traffic. The action of the surf is so violent that it was necessary to employ a small cylinder, 7 inches in diameter, instead of one of the usual size, 22 inches in diameter, for the float of the tide-gauge to work in. The cylinder is held in position vertically by three stout iron bars driven to a depth of about 9 feet into the ground, and the whole is attached by a system of chain lashings to the contiguous piles of the pier. The sea-water enters the bottom of the cylinder through a rose, which is intended to keep out the sea-weed; it then ascends through a perforation about an inch in diameter in the centre of a block of wood two feet long, which serves as a plug to the cylinder, and is capped by a metal plate, with a perforation $\frac{1}{8}$ of an inch in diameter. Thus the momentary undulations of the surface are not transmitted into the cylinder, the water in which rises and falls exactly with the tide, as has been shown by an independent verificatory gauge. The change in the cylinder necessitated the employment of a float specially constructed for these observations, and various modifications of the general arrangements and procedure, all of which have been carefully thought out, and are acting satisfactorily. In consequence of the vibrations to which the flooring of the observatory was subjected not only by the action of the sea but by the bumping of the cargo-boats against the pier and the rolling of the landing trucks, it was necessary to substitute a clock with a spring escapement for the ordinary pendulum clock by which the barrel of the gauge is usually driven.

203. The observatory and the cylinder were entirely put up under the superintendence of Captain Taylor, the Master Attendant for the Madras Presidency, to whom Captain Baird expresses himself as much indebted for the trouble he has taken to ensure success in every particular. The work was completed in January 1880, when the registrations were resumed, and they have been continued without any interruption up to the present time.

204. At Vizagapatam the tidal observations have proceeded satisfactorily; the anemometer has worked very well, but the aneroid barometer has given much trouble, necessitating constant reference to the mercurial barometer. The observatory was twice inspected, and on one occasion the clerk in charge was found to have been very negligent in rating his clocks; this work is now done under the immediate superintendence of the Port Officer.

205. At False Point considerable difficulty has been met with in obtaining a suitable site for a tidal station. The site first proposed was at Reddie Point, the extreme north end of Dowdeswell Island; but Captain Baird found it would not answer because of the varying configuration of the foreshore, the

difficulty of access and distance from the only inhabited locality in the island, the length of piping which would have been necessary to effect a connection between the sea and the observatory, and finally the general doubt of the safety of any structure erected on a moving sand-spit. He decided on erecting the observatory on a staging of piles in the harbour opposite the place called Hookey Tolah; here a few feet of piping suffices for connection with as deep water as is essentially necessary for the observations. The staging is well secured by a mass of stone rubble, and may be regarded as fairly permanent; the observatory is only accessible by boat, which is an objection, but the distance from the shore is not more than 300 yards, and the clerk in charge can readily cross at pleasure. The staging and observatory were reported complete by the Department of Public Works in September 1880, and the regular registration of observations was commenced immediately afterwards; a recent inspection has shown that the staging is not sufficiently firm to resist a strong gale of wind, and arrangements are being made for it to be materially strengthened.

206. At Rangoon a site for the observatory was selected in February 1880 by Captain Baird, in concert with the Port authorities, on the Latter Street wharf. All necessary preliminaries having been completed, the instruments were set up and registration was commenced in the same month, and has gone on satisfactorily ever since. An inspection was made by Mr. Rendell in August. As there is sometimes an interval of nearly half an hour between the turn of the tidal current and the times of high and low water, the clerk in charge has orders to note the time of the turn—as indicated by the swing of vessels at anchor in the river—and enter it in the observatory records, as often as he can conveniently do so.

207. At Elephant Point the observatory is about 50 yards from the telegraph office. It was completed and the instruments were at work by the middle of May 1880, and when inspected in August all was going on satisfactorily; shortly afterwards the piping connected with the sea was carried away by the tide, and a break of ten days on the registration was caused thereby. It is feared that a similar accident may again occur, as the bank is being constantly undercut by the very strong current which rushes past Elephant Point. The water is here highly charged with mud, which is liable to be deposited in the cylinder and piping; special arrangements have therefore been made to flush them out from time to time whenever desirable. The clerk in charge is one of the assistants in the telegraph office, who was authorized by Colonel Murray, the Director General of the Telegraph Department, to undertake the work in addition to his regular duties.

208. At Amherst the observatory is 20 feet to the north of the water pagoda, and is built, like it, on posts let into the rock. A well had to be sunk in the rock for the cylinder and a groove cut for the reception of the piping. Observations were commenced on the 30th July 1880, but it appears that the well was not sunk to a sufficient depth, as some low tides have since occurred which the instrument could not register. This must be rectified at an early opportunity. The observatory is only accessible at the times between mid-tide and low water, and by the causeway between the water pagoda and the mainland. The clerk in charge is a Telegraph Assistant; the anemometer and barometers have therefore been set up in the telegraph office for convenience.

209. At Moulmein an observatory has been set up on the main wharf opposite the Master Attendant's office, in which the anemometer and barometers are kept. Registrations were fairly commenced in April, and the work, up to the present time, has been satisfactory, but with a few breaks, owing to the occasional stoppage of the pendulum clocks, by the vibrations of the wharf, which is far from being as rigid as is to be desired. Here, too, the turns of the tidal current are observed and noted as at Rangoon.

210. Captain Bean, the Master Attendant, exercises general supervision over the observatories at Amherst and Moulmein, and Captain Baird states that he is much indebted to him for his valuable assistance and hearty co-operation.

211. At Port Blair an observatory has been set up close to the pier on Ross Island. It rests partly on the stone wharf and partly on piles, and is opposite to the Port Officer's house. Registrations were commenced in March 1880, and have been continuous up to the present time, excepting as regards the anemometer. The clerk in charge is a licensed European convict, who is also

the Port Signaller. Daily reports are sent to Captain Baird in two batches monthly by the mail steamers.

212. The barrels of all the tide-gauges are 5 feet in length, and are capable of producing diagrams of the curves of all tides of an amplitude not exceeding 5 feet between extreme high and low water on a natural scale. A gear of wheels is supplied with each instrument to enable tides of the largest amplitude to be delineated within the limits of the paper; for this purpose the scales can be changed to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ of the natural scale. In all cases the largest scale that can be employed is the one adopted. The order of scale at the several ports is the following: *Natural scale,* Madras and Paumben; *one-half,* Aden, Karwar, Beypore, Vizagapatam, and Port Blair; *one-third,* False Point; *one-fourth,* Bombay and Moulmein; *one-sixth,* Rangoon, Amherst, and Elephant Point.

213. The measure of success to be obtained in the accuracy of the tidal registrations depends very greatly on the accuracy of the adjustment of the instrument both to true time and to a definitely fixed level, so that when the pencil in traversing the paper on the barrel crosses an hour-line, the time should be exactly that of the hour indicated; and when it crosses a height-line, the height indicated should be exactly that of the momentary height of the sea-level with reference to the bed plate of the instrument or any fixed bench-mark in its neighbourhood. The several adjustments and settings are, of course, made with great accuracy before the registrations are commenced, but this would be of little use if the instruments were not maintained uniformly in exact adjustment throughout the entire period of registration. Happily there is a telegraph office at every place where a tidal observatory has been established, with the exception of Port Blair, to which time-signals are sent daily from the Madras observatory; arrangements have therefore been made to correct the clocks of the several self-registering instruments to local time, whenever necessary, by communicating with the adjoining telegraph office. For the general examination of the instruments, Captain Baird has introduced a system of periodical inspections, which results in every station being inspected once or twice in the course of the year, or more frequently if necessary, either by himself or one of his assistants. He has also drawn up a programme of instructions as to the matters to be particularly attended to during these inspections, which cannot fail to bring to light any alteration in the adjustment of the tide-gauge or imperfections in the working of the instruments generally. Sometimes a native watchmaker accompanies the inspecting officer for the purpose of repairing and cleaning the clocks. On these occasions any instrument which is found out of order is thoroughly cleaned and repaired, or replaced by another in better condition.

214. The original supply of instruments was calculated to equip six tidal stations for investigations of secular variations in the relations between the land and sea levels, such as those which have already been commenced in the Gulf of Cutch and are described in previous reports. These operations have now been suspended until a sufficient interval elapses for changes of level to take place, of a magnitude exceeding the probable errors of the determinations of mean sea-level. Meanwhile, the instruments have been lent to the minor Indian ports, which cannot afford to purchase new ones; all the principal ports have, however, been required to pay for their own instrumental equipment. In all cases the instruments have been constructed, as formerly, by Mr. Adie of London; but with various modifications and improvements, which Captain Baird's long experience in their practical manipulation has enabled him to suggest.

215. The clerk in charge of each observatory is required to send Captain Baird a daily report, which gives the hourly readings of the tidal diagrams and various items of information regarding the performances of the several instruments, which indicate whether everything has been going on properly. This report is very useful as a check on the vigilance of the observer, and a precaution against the loss of the diagrams in transmission to Captain Baird's office. The paper on the barrels of the tide-gauges is usually taken off once a week; the curves are inked in daily by the clerk in charge whenever he visits the observatory; ink of different colours is used for different days, to enable the curve of each day to be readily identified, whenever there is any overlapping, as not unfrequently happens.

216. When the whole of the diagrams for any port have been received in Captain Baird's office, whatever corrections may be necessary to the hour-lines for clock error, and to the height-lines for changes of zero or contraction of paper, are carefully made, and marked on the diagrams; then, the momentary heights corresponding to the hours are measured and tabulated. These values furnish the basis of all the subsequent calculations, by the method of harmonic analysis, as described in the Annual Report for the Great Trigonometrical Survey for 1876-77.

217. The calculations are very laborious, but fortunately they can mostly be put into a form for mechanical computation by any intelligent natives who know a little arithmetic and the use of logarithm and multiplication tables. Captain Baird has succeeded in doing this in a most satisfactory manner: by apportioning the different stages of the calculations among different computors and introducing a careful system of checks, an enormous amount of work, in the calculation of the constants for the several tidal stations, has been performed, which is highly creditable to the office.

218. The values of the constants are forwarded by Captain Baird without delay to Mr. Roberts, of the *Nautical Almanac*, to be employed in the preparation of tide-tables for each of the ports with the aid of the tide-calculating machine which he constructed for the Indian Government, as previously reported. Tide-tables for 1881 have already been computed and printed for Aden, Karachi, Okha (Gulf of Cutch), Bombay, Karwar, Beypore, Paumben, and Vizagapatam, on the basis of Captain Baird's constants. When it is remembered that up to the present time such tables have been published for no ports in India but Bombay and Karachi, the services which Captain Baird has already rendered to the Marine Authorities and navigation generally will be readily understood. I have every reason to be well satisfied with his assiduous devotion to his work, and the skill with which it is performed.*

XXVIII.—THE SPIRIT-LEVELING OPERATIONS.

1.—The Spirit-Leveling Operations in connection with the Tidal Observations.

219. These operations have been conducted under the direction of Captain Baird by Mr. Belcham, with a view to connecting the several tidal stations at different points on the Indian coasts by lines of spirit-levels, and while so doing to connect all the collateral bench-marks of the Irrigation and other Departments and reduce them to a common datum. The line from Bombay along the Great Indian Peninsula Railway, which had been carried last year to the station of Kem, was extended this year a distance of 223 miles *viâ* Gulburga to Raichur, where it was connected with the line of levels from Bangalore to Kárwár, which had been executed in 1873-75. From Gulburga a branch line of levels, 75 miles long, was carried to the Bider Base Line, one of the fundamental bases on which the principal triangulation of India depends for its linear elements. Another branch line was carried from Sholapur to Bijapur, a distance of 93 miles; smaller branches, of an aggregate length of 41 miles, were carried to connect the collateral bench-marks. In all 435 miles were leveled, in accordance with the prescribed rigorous system of operation and by two observers working independently over the same line and comparing results; 28 stone bench-marks were set up, and 337 permanent points, of which 28 were bench-marks of the Irrigation Department, were connected for future reference. The whole constitutes a very good outturn of work for the field season.†

Personnel.

Captain A. W. Baird, R.E., Assistant Superintendent 1st grade.
Mr. G. Belcham, Surveyor 4th grade, Sub-Surveyor Narsing Dass, and two Recorders.

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* Mr. Beverley joined the Tidal Office in July 1880, and was taken, with Mr Belcham, on a tour of observatory inspection by Captain Baird in the following September, in order to acquire a knowledge of the instruments and general arrangements. Mr. Rendell has been employed almost entirely in the erection of the new observatories, and has worked well. Mr. Connor has been solely employed on the calculations: he is most painstaking and diligent, and his services have been very valuable. Dhondia Vinayk, Sub-Surveyor, is one of the few educated Brahmins who is ready to travel anywhere by land or sea at a month's notice, without demur; he has been chiefly employed in teaching the observatory clerks their duties, which he does very well.

† Captain Baird reports that Mr. Belcham and Narsing Dass have done work which is very good and to his entire satisfaction.

2.—THE SPIRIT-LEVELING OPERATIONS IN CONNECTION WITH REVENUE SURVEYS.

220. The Chief Commissioner of British Burma having sanctioned the taking of levels in connection with the cadastral surveys in that Province, operations have been commenced in the Hanthawaddy District, where a small leveling party has been employed under the orders of Captain Sandeman, the executive officer in charge of the cadastral survey. Two Assistant Surveyors were successively detached for the leveling, but unfortunately both in turn fell sick, and only 30½ linear miles were accomplished. The plan of operations in the part of the District where the cadastral survey is now progressing is for lines to be run at distances of about 10 miles apart, and laid down on the maps of the Survey.

XXIX.—GEODETIC.

221. The electro-telegraphic operations, for the determination of differences of longitude, have had to remain in abeyance for another year, no officers being available to carry them on. Lieutenant-Colonel Maxwell Campbell, R.E., who was associated with Captain Heaviside, R.E., in the operations described in Section XII of the Report of the Great Trigonometrical Survey for 1876-77, returned from Afghanistan at the end of the field season and has been employed since then in preparing the volume of the Account of the Great Trigonometrical Survey which will give the details of the longitude operations of previous years. Arrangements were made for the work of observing to be resumed in the following field season, and it is now being proceeded with by Lieutenant-Colonel Campbell and Captain Heaviside, on the telegraph lines connecting Kurrachee with Calcutta.

PART II.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS' OFFICES.

222. These offices comprise—

(1) The Surveyor General's Office.
(2) The Revenue Survey Office.
(3) The Lithographic Office.
(4) The Photographic Office.
(5) The Mathematical Instrument Office.
} All in Calcutta.
(6) The Trigonometrical Survey Office, at Dehra Dun.

The five offices in Calcutta are still located as formerly in different buildings, the Revenue Survey Office, which is that also of the Deputy Surveyor General, being at a considerable distance from all the others. Very deficient in accommodation when last reported on, they are still more so now, as they are incapable of expansion to meet the growing requirements of the Department, and to provide space for the annual increasing stock of maps for general issue. At last, however, the construction of a new set of buildings to contain the several offices has been commenced, and a building is now being erected which is intended to hold the whole of the Surveyor General's Offices, and the Revenue Survey Office, under one roof. There is sufficient space on the premises for the construction of buildings for the Lithographic, Photographic and Mathematical Instrument Offices also, as soon as funds can be assigned for the purpose by the Department of Public Works.

1.—THE SURVEYOR GENERAL'S OFFICE.

223. The superintendence of the work in this office devolves on Captain Riddell and Mr. J. O. N. James. Captain Riddell has the general charge of the accounts of the three branches of the Department and the immediate supervision of the expenditure and much else in the Topographical Branch in addition to his duties as Superintendent of the Lithographic and the Mathematical Instrument Offices. Mr. James, who returned from furlough and relieved Major Steel in October 1879, has the general charge of the Drawing, Engraving and Despatch Offices. The duties of both offices are most responsible and laborious, and the Surveyor General has much reason to be satisfied with the manner in which those duties have been performed.*

Personnel.

Captain R. V. Riddell, R.E., } Dy.Supdts.,
J. O. N. James, Esq., } 3rd Grade.
H. Duhan, Esq., Personal Assistant.

DRAWING BRANCH.

Drawing and Compiling Section.

Mr. J. F. Baness, Chief Draftsman.
Mr. J. Peyton, Surveyor 1st Grade.
" F. Adams, " 3rd "
" W. Green, Draftsman.
" J. R. Adels, ditto.
" F. Volkers, ditto.
Munshee Somanlah, ditto.
" Nabbi Baksh, ditto.
Mr. J. A. Higgs, Apprentice.
" A. J. Musgrove, ditto.
" W. P. Smith, ditto.
" R. C. Sinclair, ditto.
and 14 Native Draftsmen.

Geographical Examining Section.

Mr. A. Chamarette, Surveyor 1st grade.
" H. E. T. Keelan, ditto 2nd "
" A. J. Wilson, ditto 2nd "
" R. D. Farrell, ditto 3rd "
Baboo Mohesh Chunder Shaw,
and 3 others.

ENGRAVING BRANCH.

Mr. C. W. Coard, Superintendent.
" W. Donaldson.
" G. G. Palmer.
" D. L. Mitchell.
Mr. J. Fulford.
" A. G. Palmer.
" T. B. Rodger.
" S. M. Coard.
" A. W. N. James.
" A. R. Coard.
" A. D. M. Chamarette.
" E. A. Ollenbach.
22 Native engravers and 1 clerk.

Copperplate-printing Section.

Mr. W. T. Collins.
11 native printers and pressmen, &c.

CORRESPONDENCE BRANCH.

Mr. T. W. Babonau, Registrar.
" M. Francis.
" F. A. D'Rozario.
" T. E. Ware.
Baboo Bani Madhab Banerjee.
Mr. J. A. Vallis.
Baboo Bheecum Sing,
and 6 others.

Accounts and Miscellaneous Section.

Mr. N. A. Belletty, Surveyor, 1st grade.
" E. D. Algar.
and 2 Native clerks.

Map, Record and Issue Section.

Mr. R. A. Gibson, Map Curator.
" H. R. Vallis.
" W. P. Abro.
and 1 Native clerk.

* Mr. T. W. Babonau and Messrs. Francis, D'Rozario, and Baboos Bani Madhab Banerjee and Bheecum Sing, in the Corresopndence Branch, have discharged their duties satisfactorily.

224. The work performed in the Drawing Branch during the past year was of the usual kind, *viz.*, compilations on various scales, and from various materials, for maps of the British Provinces, Native States and Afghanistan; maps to illustrate special reports; drawings for the sheets of the Indian Atlas reduced from departmental surveys; drawings for photozincography, of new editions of some of the standard sheets of old topographical surveys; copies of maps, plans, charts, &c., for various departments; and colouring of maps and plans for issue.

225. During the past year the demand for maps of Afghanistan has been great and very urgent; the compilation of new maps from time to time to embody all the latest geographical information as soon as possible after it reached the office has engrossed much of the working power of the office, and retarded the completion of various maps which were in hand and which, though of much importance, had to give way to more pressing requirements. The extensive survey operations in Afghanistan produced from time to time a large quantity of new materials which it was necessary to utilise speedily; thus, in the interval between October 1879 and August 1880, five editions of the large map issued under the successive titles of the two routes to Kabul and the Seat of War in Northern Afghanistan were compiled on the scale of 1 inch = 4 miles and published. Two editions of the map of Quetta to Kelat-i-Ghilzai and Girishk, and a first edition of the map of Sibi to Quetta and Thal-Chotiali to the Pishin Valley, have also been published on the same scale to provide for immediate requirements; as regards Southern Afghanistan and Beluchistan, a new map of these regions is under compilation and should be published shortly.

226. Additions have been made, as opportunity permitted, to the maps of India on the scales of 1 inch to 32 and 64 miles, and also to the provincial maps on the scale of 1 inch to 16 miles. The map of Bengal was ready for transfer to stone in outline when it became necessary to make numerous corrections to the boundaries of districts because of territorial alterations which had recently taken place under the orders of the Bengal Government; the hill-drawing for the western half of this map is nearly ready for the lithographer. The map of Assam, scale 1 inch = 16 miles, has been revised and completed to date in outline; a new compilation of Berar, scale 1 inch = 8 miles, has been commenced. Considerable additions have been made from recent survey materials to fifteen sheets of the Indian Atlas, and fourteen new sheets have been commenced. Four sheets of the old Ganjam and Orissa Topographical Survey, scale 1 inch = 2 miles; twelve sheets of the Hyderabad and three sheets of the Central Provinces Topographical Surveys, scale 1 inch = 1 mile, have been re-drawn and others are in hand; and a considerable amount of miscellaneous mapping has been completed. The details of all this work will be found in the usual tabular statement given in the appendix.

227. The employment of the pantograph for the reduction of survey results on the sheets of the Indian Atlas having been found both tedious and unsatisfactory, photographic reductions to the required scale are now employed instead; with careful manipulation in setting the reduced photographs on the points fixed by triangulation and the intersections of the lines of latitude and longitude, all desirable accuracy is obtained and the draftsman is less embarrassed in deciding what details should be omitted to suit the reduced scale of his drawing.*

228. The *Examining Branch* has worked very satisfactorily in the careful examination and scrutiny of all the mapping and field work received from the several survey parties, also of the work performed in the drawing office, and of the proofs from the lithographic, photozincographic and engraving offices; 40 of the standard sheets of the topographical surveys, 34 original compilations and drawings of various kinds and 254 proofs of engravings, lithographs and zincographs have been examined. In addition to this a large amount of miscellaneous work, including the projection of lines of latitude and longitude, and

* Mr. James reports as follows:—

Considerable improvement appears in the hill-shading by brush-work since Mr. Peyton joined the office; his excellent specimens of hill-drawing not only serve as models for the guidance of less experienced draftsmen, but are highly appreciated by the hill-etchers in the Engraving Office. Efforts are being made to introduce hill-shading by vertical hachures on the original maps prepared for the lithographers and engravers, and also for photozincographic reproduction, but the draftsmen are new to this style of hill-drawing, and time is necessary to perfect them in it. This measure, it is expected, will, if it can be satisfactorily carried out, enable the hill-etchers and lithographers to work with greater facility and accuracy from originals prepared in the style in which they express hills on copper and stone, than in transposing brush-shading into vertical hachure-shading.

trigonometrically fixed points and calculations of area, &c., for statistical reports has been performed.*

229. *Engraving Office.*—This office was primarily formed for engraving the sheets of the Indian Atlas on the scale of 1 inch = 4 miles. But, as there is a much larger demand for the several smaller-scale maps of India, and the various Provinces, and these maps require to be at least as highly finished as the Indian Atlas, new editions of those maps have either been already put into the hands of the engravers or are in progress with that object. Now, it so happens that there are still very large areas within and on the frontier of India which have not been surveyed at all, or only very roughly, so that the materials for filling in these areas on the maps are far less accurate and satisfactory than those for the areas which have actually been surveyed. In such cases the work of the engraver is restricted within the limits of exact survey, as it is not desirable that anything should be engraved on the copper-plate which may soon require to be erased. When the engraving is completed so far, a transfer is made from the plate to a lithographic stone, and the remaining details are drawn on the stone, which is a much quicker and less expensive process than engraving on metal. The map is then ready for publication as a preliminary edition. Even when the whole of the materials are exact, it is sometimes necessary to make a transfer from the copper to the stone, for maps containing much hill work, as soon as the engraving of the names and outlines is completed and before the etching of the hills is commenced; for etching on copper is a slow and laborious process; so a preliminary edition of the map with the hills drawn on stone is occasionally required as a make-shift until the more beautiful and highly finished etching on copper can be completed.

230. Of the map of India, scale 1 inch = 32 miles, sheet 1 of the Punjab and the North-West Frontier has been transferred to stone, but it requires large corrections for Afghanistan. Sheet 2 has been drawn on stone, as it contains incomplete geography relating to the northern portions of Nepal, Bhotan, and the course of the Sanpu River; sheets 3, 4, 5 and 6 are also ready for transfers to stone in outline. The blanks on these sheets for the unsurveyed portions within and beyond India will be drawn on stone from the best available maps of routes and explorations; the hills will also be completed on stone for a first edition. Large additions from surveys in progress have been made to the map of India, scale 1 inch = 64 miles, to complete it up to date, and a fresh transfer to stone has been taken. The maps of Bengal and Assam, scale 1 inch = 16 miles, have been completed in outline; the map of the Central Provinces, on the same scale, is nearly ready, and the maps of the Rajputana and Central India Agencies are near completion up to the limits surveyed. Twelve new quarter plates, which were in various stages of progress last year, have been completed and published, and twenty-six others have been fairly advanced either in outline and writing, or in hill-etching. Additions and corrections from surveys in progress and new lines of roads and railways have been inserted on nineteen plates, and repairs to outline, writing and hills have been well advanced on nine plates.

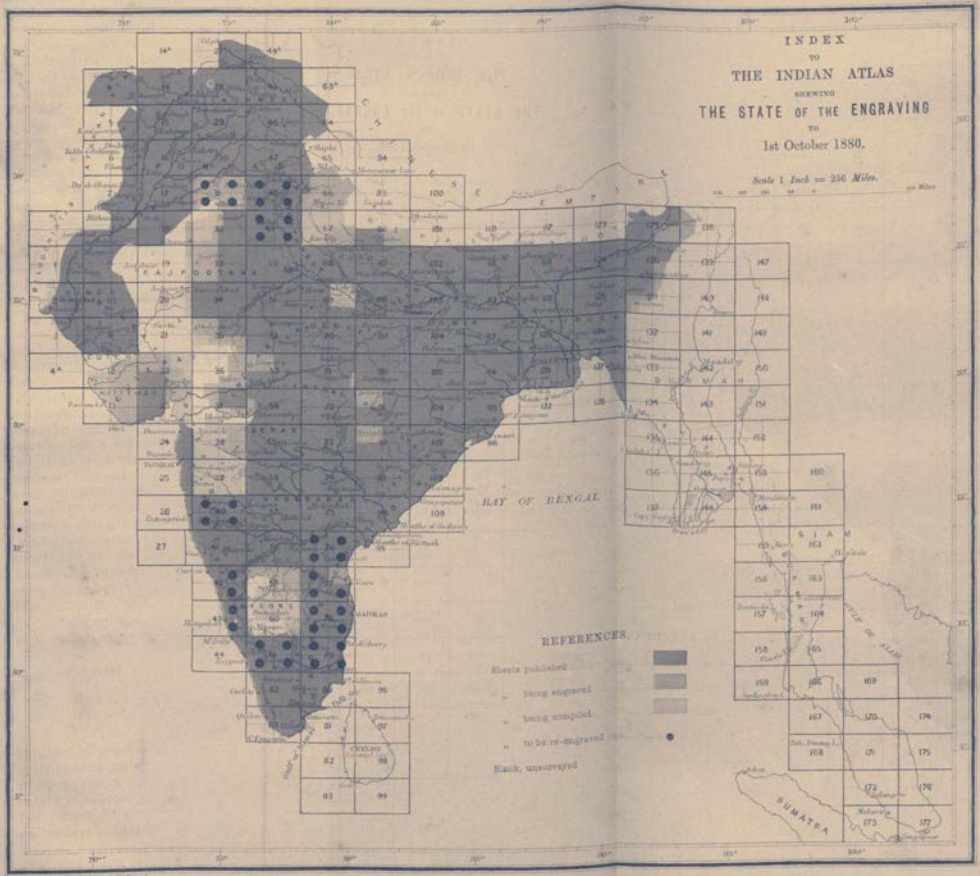
231. The total outturn, reckoned as it was last year, in square inches, is as follows:—

		Square inches.
New work, outline and writing		4,106
Do. hill-etching and sand-dotting		1,630
Repairs of old work	outline and writing	731
	hills and sand	1,336

Owing to the intricacies of the work in its various stages of outline, lettering of different kinds and sizes, ornamentation, hill-etching, sand-dotting and corrections, and the number of hands through which each plate passes in various stages, it is very difficult to arrive at any satisfactory method of classifying and calculating with fair accuracy the actual outturn of work; but efforts are being made to arrive at some fairly accurate system of estimating the outturn and checking the cost.

232. In addition to the above, much useful miscellaneous work has been completed, a variety of scales have been engraved, a drawing of an idiometer

* Mr. A. Chamarette, Surveyor and Head Examiner, deserves much credit for the zeal and ability with which he performs his duties; his assistant, Mr. A. J. Wilson, has worked well and shows much aptitude as an examiner. Baboo Purna Chundra Sen has given satisfaction.



Published under the Direction of Major General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.
Surveyor General's Office, Calcutta, December 1880.

to illustrate one of the forthcoming volumes of the Account of the Operations of the Great Trigonometrical Survey has been very skilfully etched on copper, and a chart of the Indian ocean showing the localities of all wrecks has been commenced for the Marine Survey Department.

233. The process of steel facing continues to be performed on the copper-plates successfully, and without any detriment to the plates, such as happened when it was originally commenced in this office. Twenty-two of the new quarter plates of the Indian Atlas and seventeen of the old full plates (double elephant size) have been thus treated and printed from; none of the plates show the least sign of wear or of suffering from rust or other effects of climate. To preserve the steel facing it is sufficient to apply coatings of Brunswick black at stated intervals. The steel surface preserves the most delicate portions of the work on the copper plates from wear or deterioration in the press; thus it is no longer necessary to make transfers from the copper-plate to stone, that prints may be taken from the stone in order to preserve the plate, but prints are taken directly from the plate, and with the satisfactory result of being sharper and clearer than those from the stone. Full details of all the work completed and in progress in the Engraving Branch are given in the appendix.*

234. The Map Record and Issue Section has continued to work under considerable pressure caused by the large demand for maps of Afghanistan and the North-West Frontier; the issue of maps to agents for sale to the public has also been greater than usual. The applications received for maps by letters, indents and telegraph messages numbered 2,228; the letters issued either in reply or as advice were 1,290; the invoices and map receipts issued numbered 3,282. The total number of packets and parcels despatched were 5,774.

The map issues have been as follows:—

	Maps.	Value. Rs.	A.	P.
To Government officials	26,597	42,806	4	9
„ India Office, London	3,225	6,104	6	0
„ Agents for sale	3,974	8,095	1	0
Total . .	33,796	57,005	11	9

In this branch of the office 22,662 sheets of maps and plans were coloured by contract.† The amount realized by the sale of maps and placed to the credit of Government by this office, is Rs. 9,621.

235. The re-arrangement, classification under distinct heads in accordance with the present territorial divisions of India, and cataloguing of the original maps in the office have been gone on with as opportunity permitted. Section III, which comprises the river, canal and railway maps, has been completed; and Section IV, which comprises maps of civil divisions in the three Presidencies and Native States, is in hand. In these two sections, 1,734 maps in 4,071 sheets have been examined, grouped according to their respective divisions, labelled or ticketed, and numbered and catalogued. Formerly the maps were kept in rolls, but they are now folded suitably and laid flat, a form in which the maps are more easily accessible and less liable to injury. This work, which is likely to take more than a year to complete, was not commenced a day too soon, as the numerous changes which have taken place in the limits, both external and internal, of the several jurisdictions, provinces, districts and Native States in India had much impaired the value of the old registers of maps, and made most of them almost useless, so that much time was liable to be lost in searching for old records under different heads.

* Mr. C. W. Coard, Superintendent of Engravers, has performed his duties satisfactorily and has paid good attention to the training of the native staff. Mr. W. Donaldson and Mr. J. Fulford, Outline and Writing Engravers, have rendered very efficient aid in various ways. Mr. G. Palmer's style and out-turn of hill-etching has been most satisfactory. Messrs. D. Mitchell and A. Palmer, hill-etchers, have worked well. Mr. S. Coard has been very successful in steel-facing the engraved plates of the Indian Atlas and has shown considerable skill in mechanical engraving. The European apprentices under Messrs. Donaldson and G. Palmer have made good progress in hill-etching and are able now to take a share in regular work. Several of the native engravers have made good progress and are now employed both in hill-etching and writing on various plates.

† Early in the year Mr. T. W. Babonau was appointed registrar in this office and was succeeded in the post he previously held of Map Curator by Mr. R. A. Gibson.

2.—The Revenue Survey Office.

236. A summary of the results and cost of the field work of the several parties of the Revenue Branch is given at page 64. A statement of the principal records prepared in the executive offices is given in table A at page 62 of the appendix; a detailed statement of the work done by the Drawing Branch of the Head Office is given in table B at page 63 of the appendix; and table C, at page 67 of the appendix, shows the state of the publication of the cadastral maps.

PERSONNEL.

Lieutenant-Colonel J. Sconce, Deputy Surveyor General, and Superintendent, Revenue Branch.
Major F. Coddington, Deputy Superintendent, 2nd grade.

DRAWING BRANCH.

Mr. F. W. Kelly, Surveyor and Head Draftsman.
„ J. Connor, Assistant Surveyor and Draftsman.
Sheikh Mehir Ally, Draftsman.
„ Golam Mohamed, „
„ Abdul Aziz, „
„ Rohim Bux, „
and 5 other draftsmen and 7 colorists.

Map Examining.

Mr. J. A. May, Surveyor and Draftsman.
„ T. W. Reilly, „ „
Sheikh Abdur Razak, Draftsman.
„ Wahed Bux „

Computing and record examining.

Baboo Harihur Sen, Head Computer.
„ Tincowry Sen, Computer, and two others.

Cadastral map examining.

Mr. W. Sinclair, Surveyor and Draftsman.
Sheikh Kodrut Alli, Draftsman, and 5 other draftsmen and one clerk.

Records and map issue.

Mr. W. J. Lane, Assistant Surveyor.
Baboo Ashootosh Kur, and 1 other.

CORRESPONDENCE AND ACCOUNTS BRANCH.

Correspondence.

Mr. A. E. Byrn, Registrar.
„ A. C. Cunningham, Head Clerk.
Baboo Kallypudo Banerjee, Clerk.
„ Doorgamarain Ghose „
„ Ramkisto Chunder „
and 5 other clerks and copyists.

Accounts.

Mr. Gopal Chunder Laha, Head Accountant.
Baboo Bama Churn Chuckerbutty, Accountant, and two others.

Despatcher.

Baboo Judo Nath Mookerjee.

237. The summary of the field work shows there has been an increase of 1,018 square miles in the cadastral area over the return of the previous year, while the general rate of 5 annas 8½ pie per acre is very similar to the general rate of the 16-inch surveys of last year, though all the old parties show a considerable reduction in their rates. The village survey area, on the 4-inch scale, is 2,373 square miles less than last year, chiefly owing to the abolition of one of the parties. The Topographical Survey area on the 2-inch scale by revenue survey parties is 378 square miles more than last year.

238. The following original maps received from Executive Officers have been examined and published during the year, *viz.*:—

Sirsa District	.	.	16 sheets on 1-inch scale.
Deccan Topographical Surveys (drawn in 24 sections on 2-inch scale)	.	6	„ „ „

The following maps drawn in the Head Office have also been published, *viz.*:—

Bannu and Dera Ismail Khan Districts (drawn in 36 sections on 2-inch scale)	9	sheets on 1-inch scale.
Midnapore District (drawn in 56 sections on 2-inch scale)	14	„ „
Muttra District (drawn in 28 sections on 2-inch scale)	7	„ „

The disposal of the cadastral maps has continued to occupy the attention of a large section of the office; 2,985 maps and the proof copies of 2,926 have been examined between 1st January and the 30th September, up to which date the return has been prepared to agree with the other returns of the department. All the maps have this year been published at the Photographic Branch of the Surveyor General's Office.

239. The records received from field parties during the year have all been carefully examined, and a percentage of the computations of 4 districts has been checked. Revised area statements of districts Midnapore, Hooghly, Muttra, and Jhung have been made according to revised limits. The preparation of the new register of the records in the Head Office has been continued. A large part of the correspondence section of the office continues to be employed in checking the bills of the field parties and in keeping the accounts of the Revenue Branch generally.

240. The Deputy Surveyor General again acknowledges the very valuable aid which Major F. Coddington, on duty in his office, has rendered to him.*

3.—Lithographic Branch.

241. The total number of maps, plans, diagrams, &c., printed during the year, amounts to 160,346 copies; of these 119,100 copies, or nearly three-fourths, were done for other departments and were very varied in character; the remainder were printed for the requirements of this Office.

Personnel.

Captain R. V. Riddell, R. E., in charge.
Mr. E. Jevezy, Head Assistant and Chief Draftsman (on furlough).
„ H. L. Lepage, Officiating ditto.
Mr. H. Ferns . . .
Baboo Buloram Nath . .
Munshee Mahomed Azim . . } Draftsmen.
„ Sobhan Buksh . .
and 21 others . .
Mr. H. Niven, Chromo-Printer.
„ E. D'Pyvnh, Printer.
1 Press Assistant and 17 others.
3 Native Clerks.

242. The map of the District of Maldah, on the scale of 1 inch = 1 mile, has been lithographed. The 1-inch = 1 mile maps of the Districts of Jalpaiguri and Noacolly have been taken in hand during the year, the former in 13 sheets and the latter in 12 sheets. The stock of several of the sheets of the Oudh map on the scale of 1 inch = 1 mile having become nearly exhausted, a second edition has been commenced; 3 sheets have been drawn, and the modern spelling has been adopted.

243. Maps of the Districts noted in the margin have been transferred to stone from the copper-plates of the sheets of the Atlas of India and published during the year. Similar maps are under preparation of six other Districts, *viz.*, Mymensing, Dacca, Furreedpoor, Backergunge, Noacolly and Sylhet. Copies of the sheets of the Atlas of India specified in the margin have been transferred to stone from the engraved plates, corrected up to date on the stone and printed to meet immediate demands, the original stock having become exhausted.

District Rungpore.
„ Dinagepore.
„ Shahabad.
„ Jalpaiguri.
„ Gya.

Quarter sheet, No. 66 S. W.
„ „ „ 71 N. E.
Full sheet, No. 68.
„ „ „ 111.
„ „ „ 103.
„ „ „ 104.

244. A preliminary edition of the map of India, scale 1 inch = 64 miles, with the outlines transferred from the copper-plate and the hills drawn on the stone in chalk, has been completed and published to meet immediate requirements pending the completion of the hill-etching on the copper, as the demand for this map is very great.†

4.—The Photographic Office.

Personnel.

Major J. Waterhouse, B.S.C., Assistant Surveyor General, on furlough from 11th December 1879.
„ S. H. Cowan, B.S.C., Officiating Assistant Surveyor General, in charge.

Negative Branch.

Mr. J. Mackenzie, Photographer.
„ C. Marshall, ditto.
„ L. Lagnier, ditto.
„ G. G. Dempster, ditto.
„ T. Lloyd, ditto.
and 10 assistants.

Silver Printing Branch.

Umbica Churn Bhattacharjee, Assistant Photographer, and 1 native assistant.

Zinc Printing Branch.

Mr. B. Mackenzie, Zincographer.
„ J. Watson, ditto.
„ E. A. LeFrane ditto.
12 zinc correctors, 12 printers, 7 grainers and 36 pressmen.

245. The tabular statements in the appendix give full details of the account and value of the work executed in this office on account of the Survey Department, and a summary of the work done in compliance with the

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* Mr. F. W. Kelly, Surveyor 1st grade, has continued to do excellent work as Head Assistant in the drawing branch. Mr. Sinclair's duties in connection with the publication of the cadastral maps have been very laborious, and he has given entire satisfaction.

Messrs. J. A. May, T. W. Reilly, J. Connor and W. J. Lane, Surveyors and Draftsmen, have all worked well in their own branches of the office.

Mr. A. E. Byrn, Mr. A. C. Cunningham, Mr. Gopal Chunder Laha, Baboos Harrihar Sen, Kallypudo Banerjie, Doorgunarain Ghose and Judo Nath Mookerjee, together with the rest of the establishment, have all given satisfaction.

† In June last, Mr. Jevezy, who had been Head Assistant for 10 years, obtained furlough to Europe, and his duties have since been performed by Mr. Lepage.

Captain Riddell states that the following Draftsmen are worthy of special mention, on account of their skill and assiduity:—

Boloram Nath, Mahomed Azim, Diuo Nath, Umbica Churn Mookerjee, Abdool Hamid, Abdool Mojid, Mahomed Yeasin and Deno Nath Dass.

Photographic Transfer Branch.

Mr. J. Harrold, Photographer.
„ R. George. ditto.
and 2 native assistants.

Office and Store Branch.

Mr. A. E. Caddy, Store-keeper and General Assistant.
Syud Ishmail, Head Clerk and Accountant, and 4 native clerks.

requirements of all other departments; also an abstract of the cost of the office.

246. The details of the work executed during the year are shown in the following table:—

Abstract of work performed in the Photographic Office, from 1st October 1879 to 30th September 1880.

	Original Section or Sheets.	Negative plates.	Photographic transfer prints.	Transfer to zinc or stone.	Number of pulls.	Number of printed sheets of each subject.		Silver and other prints.	Remarks.
Topographical maps	72	224	189	58	7,527	7,527	7,527	...	
Revenue Survey „	288	383	469	56	10,658	10,678	10,570	...	
District maps	...	...	...	2	310	310	310	...	
General „	13	2	...	38	5,980	4,350	4,350	...	
City and Cantonments. Plans	12	55	55	144	2,680	2,685	685	...	
Miscellaneous Department	502	637	573	409½	31,342	39,664	31,471	...	
Ditto extra-departmental	542	628	649	390	64,058	1,91,431	1,85,371	...	
Transfers and proofs	...	...	—	...	2,595	...	...	...	
Pigment prints	...	...	...	...	...	...	...	29	
Platinum „	...	...	...	...	...	...	...	56	
Silver „	...	...	...	...	...	...	...	932	
Total	1,429	1,929	1,935	968	125,150	256,670	140,309	1,017	
Cadastral, North-Western Provinces	...	...	...	...	...	...	...	...	
Photozincographs	2,000	2,000	2,105	2,160	58,307	58,307	41,578	...	
Zincographs	408	...	...	367	9,369	9,369	8,544	...	
Total	2,408	2,000	2,105	2,527	67,676	67,676	50,122	...	
Cadastral, Lower Provinces	...	...	...	...	...	...	...	...	
Photozincographs	941	909	910	941	39,689	39,689	11,739	...	
Zincographs	73	...	...	73	3,913	3,913	2,050	...	
Total	1,014	909	910	1,014	43,602	43,602	13,789	...	
Cadastral, British Burma, Photozincographs	5	5	1	1	120	120	120	...	
Transfers and proofs for cadastral maps	...	...	...	...	7,006	...	...	...	
Grand Total	4,856	4,843	4,951	4,510	243,554	368,068	204,340	1,017	

247. The number of cadastral maps of the North-Western Provinces published during the year is 2,527, of which 2,160 were photozincographed, 113 were printed from re-transfers and 254 from transfers traced by hand. It is satisfactory to note that a large proportion of these were the results of field work of the cold season of 1879-80. Of the Government estate of Khorda in District Pooree 1,014 maps were published, of which 941 were photozincographed.

The work done for other departments forms a very large proportion of the total outturn of the office, amounting to upwards of $\frac{2}{5}$ of the whole, excluding cadastral maps.*

5.—THE MATHEMATICAL INSTRUMENT DEPARTMENT.

248. During the year 1879-80 the receipts of instruments in the depôt were as follows: about 250, in value Rs. 8,200, were obtained from England; nearly 1,300 were purchased in the local market, at a cost of a little more than Rs. 6,900; about 4,500 were manufactured on the premises, at a cost of Rs. 13,300; over 7,700 instruments, in value about

Personnel.

Captain R. V. Riddell, R.E., Superintendent.

Workshop Branch.

Mr. R. Wehlisch, Mathematical Instrument Maker (on furlough).
Mr. T. Bolton, Officiating Mathematical Instrument Maker.
Mr. J. Keymer, Officiating Assistant Mathematical Instrument Maker, from 1st April to 8th September 1879.
Mr. B. J. Cardozo, Officiating Assistant Mathematical Instrument Maker, from 1st December 1879 to 31st March 1880.
66 Permanent artificers and on an average 77 temporary artificers.

Store Branch.

Mr. G. R. Alderman, Store-keeper.
Baboo Womesh Chunder Chowdry, Packing Sircar.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ J. W. Collins, 2nd „
6 other Permanent Clerks and 2 Extra Clerks.

* Major Cowan speaks very favourably of Messrs. J. Mackenzie, B. Mackenzie, J. Harrold, and Caddy; he also commends Messrs. Marshall, Lagnier, and LeFranc.

Rs. 67,000, were received by inter-departmental exchange; of which about 290 were serviceable, and 4,800 were repairable. The serviceable stock was further increased by more than 4,300 instruments which had been repaired and rendered fit for future issue, at a cost of a little over Rs. 13,300, and after repair were valued at nearly Rs. 45,600. Over 1,600 instruments were repaired for various departments at a cost of Rs. 11,522.

249. More than 14,000 instruments, in value over Rs. 1,07,200, were issued during the year, *viz.* :—

	Approximate Number.	Approximate Value.
To the Survey Department	5,450	37,600
„ Marine „	25	980
„ Telegraph „	13	460
„ Military „	390	9,770
„ Public Works „	2,740	32,500
„ Educational „	480	2,210
„ Miscellaneous „	4,680	20,630
„ Road Cess Committees, District Engineers, &c., entitled to receive instruments on payment	185	2,200
„ Workshop to complete repairs of instruments	140	880
	14,103	1,07,230

The principal instruments issued were of the same class, for the several departments concerned, as those enumerated in paragraph 355, page 70 of the General Report for the year 1878-79.

250. The following statement shows the detail of the principal instruments locally purchased, their cost, and, as far as comparison can be made, the excess of the Calcutta prices over the values at which they would have been issued had they been procured from England.

Names of Instruments.	No. of instruments purchased.	Amount paid in Calcutta.	Issue value of corresponding instruments obtained from England.	Excess of Calcutta prices over issue value.
		Rs. A. P.	Rs. A. P.	Rs. A. P.
Barometers, aneroid, pocket	16	965 8 0	750 0 0	215 8 0
Compasses, Napier's, and pillar	5	128 0 0	99 0 0	29 0 0
Lenses, reading	24	70 4 0	52 0 0	18 4 0
Levels, reflecting	7	271 0 0	230 0 0	41 0 0
Protractors	46	558 0 0	408 0 0	150 0 0
Scales, plotting, &c.	90	540 0 0	452 0 0	88 0 0
Sextants, pocket	4	360 0 0	260 0 0	100 0 0
Tapes, measuring	475	3,470 0 0	2,893 0 0	577 0 0
Total	667	6,362 12 0	5,144 0 0	1,218 12 0

It is not easy to form an exact estimate in all cases of the values at which instruments locally purchased might have been procured from England, for so much depends on the quality of the instruments; but, as far as a comparison can be made, the result shows that the rates paid here were about 25 per cent. in excess of the rates at which the several instruments might have been issued had they been procured from England. The purchase of instruments to the value of at least Rs. 2,000 was due to sudden demands to meet the requirements of the Afghanistan Expedition.

251. The principal instruments manufactured in the workshop are detailed below:—

Names of Instruments.	No. manufactured.	Cost of manufacture.
		Rs. A. P.
Boards, drawing	13	125 6 0
Chains of various sizes	316	2,226 11 0
Plane-tables	208	2,337 14 0
Rules, electrum, on rollers	72	1,536 7 0
„ sight, for plane-tables	78	496 14 0
Scales, offsets, metal	36	153 10 0
Squares, optical	100	647 10 0
„ set, wooden	144	122 6 0
Stands for plane-tables	115	1,156 6 0

The savings effected by departmental manufacture have been calculated at about Rs. 2,000, or very nearly the same as in the previous year.

252. Besides the ordinary instruments above referred to, an idiometer designed by Lieutenant-Colonel W. M. Campbell, R.E., which has for some time past been under construction, under his own supervision, has been completed. The object of this instrument is to afford means of measuring the absolute personal equations in observations of star transits recorded on a chronograph. The general arrangement is that of a moveable frame, carrying vertical wires, in imitation of the wires of a telescope, which passes in front of a fixed imitation star; a small observing telescope is attached to the wire frame, so as to follow its movements, and thus the appearance of fixed wires and a moveable star is obtained. As each wire passes the star two signals are recorded on the chronograph, one by the observer and the other automatically by the instrument.

253. The total number of instruments repaired in the workshop was about 6,000, and the value of the repairs has been calculated at Rs. 25,065. The principal instruments repaired were as follows:—

	Number repaired.		Number repaired.
Chains	582	Scales	729
Drawing instruments of sorts	1,025	Sextants	31
Compasses, prismatic	106	Squares, optical	312
„ surveying	176	Stands for various instruments	468
Levels, dumpy	79	Staves, levelling	65
Plane-tables	246	T squares	101
Rules, flat, and parallel	445	Theodolites	113
Rules, sight, for plane-tables	259		

254. The receipts from England were exceptionally small, the greater proportion of the stores due during the year having arrived after its termination.

255. The aggregate cost of the portion of the establishment which was employed in the construction and repair of instruments, the cost of the material expended, the share of office accommodation, the estimated loss of wear and tear of block, and other petty contingencies, amounted in all to about Rs. 41,750; this sum is almost exactly balanced by the value of work done as estimated in the case of instruments manufactured, by the value at which they are issued; and in the case of instruments repaired, by the difference between the value at which they are issued or placed in store for future issue and that at which they were rated previous to repair. The cost of the remaining portion of the establishment, including supervision, office accommodation, packing expenses, &c., was about Rs. 18,300. This may be considered to have been expended on the receipt and issue of over 32,400 instruments valued at about Rs. 2,16,000.

256. Towards the end of the year stock was taken, and, as the rating was found to be generally at too low values, the occasion was taken to make a re-valuation. The serviceable and repairable instruments taken together, exclusive of material, machinery, and plant, were found to be over 42,000 in number, and in value about Rs. 3,18,000.*

* On the 7th November 1879 Mr. Wehlisch, Mathematical Instrument Maker, returned from furlough, but in a few days was invalided to Europe as unfit for further service in India. Thus the duties of Instrument Maker again devolved on Mr. Bolton, by whom they have been carried out very satisfactorily. Arrangements have been made to secure the services of a trained Assistant Mathematical Instrument Maker from England.

6.—The Trigonometrical Survey Office.

257. The principal work of this office is the final reduction and publication of the triangulation of all parts of India, and the reproduction of the Surveys executed in the Trigonometrical Branch of the Department. The office being located at Dehra-Dún, at a considerable distance from Calcutta, has a Drawing Branch, a Photozincographic Branch, and a Printing Branch of its own; it is thus independent of all extraneous assistance in the matter of publication, excepting as regards the binding of its productions, which has to be done elsewhere—usually at Calcutta. The office has also a depôt of instruments and stores attached to it, chiefly containing the higher class of instruments appertaining to the Trigonometrical Survey, of which it has long been the Head-Quarters Office. It is now, and has for many years, been under the immediate and able superintendence of Mr. Hennessey, M.A.,F.R.S., who is well aided by Mr. Cole, M.A.

PERSONNEL.

J. B. N. Hennessey, Esq., M.A.,F.R.S., Deputy Superintendent 1st Grade, in charge.
W. H. Cole, Esq., M.A., Assistant Superintendent 1st Grade.

Computing Branch.

Mr. C. Wood, Surveyor 2nd Grade.
„ H. W. Peyebers, „ 4th „
Babu Gunga Persad, Computer.
„ Cally Mohun Ghose, „
„ Kally Coomar Chatterjee „
and 10 other Computers, &c.

Printing Branch.

Mr. M. J. O'Connor, Printer,
and 15 Compositors and Apprentices.

Correspondence and Stores.

Mr. L. H. Clarke, Surveyor 2nd Grade, from 1st October 1879 to 7th December 1879.
Mr. W. Todd, Surveyor 2nd Grade, from 8th December 1879 to 31st July 1880.
Mr. H. E. T. Keelan, Surveyor 2nd Grade, from 1st August 1880,
and 2 Native Writers.

Solar Photography.

Mr. L. H. Clarke, Surveyor 2nd Grade, from 8th December 1879.

Photozincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
1 Native Apprentice Photographer.
2 „ Draftsmen.
1 „ Apprentice Draftsman, and 1 Map-keeper.

Drawing Branch.

Mr. W. Todd, Surveyor 2nd Grade, from 1st October 1879 to 15th November 1879.
Mr. G. W. E. Atkinson, Surveyor 3rd Grade, from 16th November 1879.
Jafir Khan, and 6 other Draftsmen.
1 Assistant Draftsman, and 14 Apprentices and Map Colourists.

258. The great work of the final reduction of the observations and measurements, both linear and angular, of the Great Trigonometrical Survey, and the publication of the results, has been making good progress.

259. The final reduction of the astronomical observations for determinations of latitude had long remained in abeyance, pending the publication by the principal observatories in Europe and other parts of the globe of star catalogues, giving the places of the stars to which observations have been taken with sufficient exactitude for geodetic investigations. The place-values which are given in different catalogues often differ materially, when reduced to a common epoch, and it is no easy matter to determine the exact position of a star at any time when it may happen to have been observed, during the period of 80 years which has elapsed since geodetic operations were commenced in India. This work, which is a necessary preliminary to the final reductions, has been taken in hand by Mr. Hennessey during the present year, and is being proceeded with very satisfactorily; it is now so far advanced that the printing of Volume IX of the Account of the Operations of the Great Trigonometrical Survey, which is intended to contain the latitude observations, has been commenced.

260. The longitude observations are of comparatively modern origin, having been commenced in 1872, by electro-telegraphic determinations of differences of longitude. Operations had been carried on through three field seasons, when they were put a stop to as no officers were available to go on with them. The return this year from Afghanistan of Lieutenant-Colonel Campbell, who had been employed in the whole of the operations already completed, has enabled the final reductions to be taken in hand. Thus the printing of Volume X, which is to be devoted to the electro-telegraphic observations and their results, has been commenced and is now well advanced.

261. The final reductions of triangulation have been principally those connected with the adjustment of various secondary chains of triangles, which depend on the already reduced principal chains that appertain to the three great sections of the principal triangulation known as, *first*, the North-West Quadrilateral, of which the results are published in Volumes II, III, and IV of the Account of the Operations of the Great Trigonometrical Survey; *secondly*, the South-East Quadrilateral, now being published in Volume VI;

and, *thirdly*, the North-East Quadrilateral, forming the subject of Volumes VII and VIII, not yet published. The final reduction of the two great sections of the principal triangulation which are still unreduced, *viz.*, the South-West Quadrilateral and the Southern Trigon, was initiated as soon as possible after the completion of the triangulation in the Madras Presidency,—see paragraphs 3 and 12.

262. Each of the volumes above mentioned requires much explanatory matter, descriptive of the general progress of the operations, and of the general principles on which the final calculations have been carried out in order to obtain the most probable results of the observations. This work has been completed for Volume VI during the present year, and commenced for Volumes VII and VIII, and has been mainly performed by Mr. Cole.

263. Volume V, giving the account of the Pendulum Operations, which was stated in the last report to be in the hands of the bookbinder, has been published, and presentation copies have been supplied to all leading scientific societies, libraries, and geodesists in all quarters of the globe. The printing of Volume VI was completed, and the sheets were ready to be sent to the bookbinders. It is expected that Volumes VII and VIII will be published by the end of 1881. Portions of the four following volumes have also been printed.

264. Of the Synoptical Volumes—which give a précis of the results of the triangulation, both principal and secondary, for the requirements of topographers and geographers—volumes 7 to 9 were published during the year, 10 to 13 were ready for the binder, and 14 more were well advanced towards completion.

265. The Auxiliary Tables for facilitating the calculations of the Indian Survey Department have been supplemented by a table of "mile-equivalents in feet and links," and a table for readily determining the so-called "subtended angle" for observations of unreciprocated vertical angles.

266. A pamphlet, giving the results of the spirit-levelling operations in portions of the Bombay Presidency, has been printed. A large amount of data of spirit-levels, taken by officers of the Irrigation Department in various parts of India, but chiefly in the Punjab, has been collected and is being embodied into the departmental charts of spirit-levels.

267. In the Drawing Office considerable progress has been made towards the completion of a fifth edition of the Turkestan Map; but the advent of new materials from various quarters, including Russia as well as Afghanistan, has much retarded publication, in some cases necessitating the re-drawing of large portions of the map.

268. Various charts of triangulation, with full numerical details, have been published, including the triangulations to Quetta, Khelat, and Kandahar. Ten charts have been prepared and photozincographed to illustrate the principal and synoptical volumes. All the maps of the current year's work of the Guzerat and Kattywar Topographical Surveys, and of the Forest Survey Department, have been published in this office, and also various maps of portions of Afghanistan, which were drawn at the Mussoorie Head-Quarters by Captain Holdich, Major Beavan, and Lieutenant Gore.

269. The taking of daily photographs of the sun, which had been suspended since the death of Mr. Meins on the 31st March 1879, was resumed on the 17th December by Mr. L. H. Clarke, acting under Mr. Hennessey's supervision, and with occasional assistance from the Photographic Office. During the 289 days from 17th December 1879 to 30th September 1880, solar phenomena were visible on 191 days; no phenomena were visible on 47 days, and there were 51 days of bad weather when the sun was hidden by clouds and remained invisible throughout the day.*

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* Mr. Hennessey acknowledges the valuable assistance he has received from Mr. Cole in general co-operation and supervision.

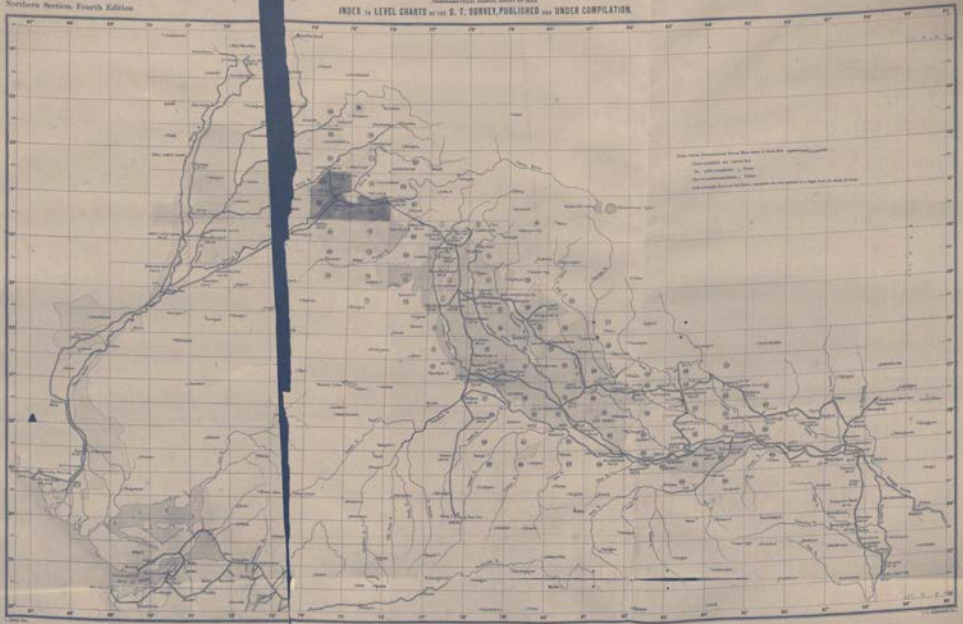
He also reports very favourably of the services rendered by Mr. Wood, and Babous Gunga Persad and Cally Mohun Ghose in the Computing Office; and commends Messrs. Atkinson, Peychers, Ollenbach and Dyson.

Northern Section. Fourth Edition

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX TO LEVEL CHARTS OF THE G. T. SURVEY, PUBLISHED AND UNDER COMPILATION.

Sheet No. 1.



Abstract of the Outturn of Work executed by the TRIGONOMETRICAL PARTIES during the Survey year 1879-80.

Description of Details.	Madras Coast series 24-inch theodolite.	Eastern Sind 24-inch theodolite.	Eastern Frontier 24-inch theodolite.	Totals.
Number of principal stations newly fixed	11	12	3	26
Do. do. triangles completed	16	16	4	36
Lengths of principal series in miles	68	64	33	165
Area of principal triangulation in square miles	2,001	1,278	670	3,949
Average triangular error in seconds	0".26	0·34	·43	...
Do. probable error of angles in seconds ±	0·13	...	·37	...
Astronomical azimuths of verification observed	2	1	0	3
Number of principal stations selected in advance	...	...	...	...
Lengths of principal approximate series in advance	...	...	...	...
Number of towers, pillars and platforms constructed for principal stations	7	...	...	...
Number of scaffolds erected for principal stations	1	...	...	...
Do. principal stations placed under official protection	13	15	5	...
Do. do. do. protected and closed	...	13	...	...
Do. do. do. the elements of which have been computed	13	...	...	...
Do. secondary stations fixed	17	16	...	33
Do. do. triangles, of which all three angles have been observed	20	20	...	...
Do. do. do. of which only two angles have been observed	73	18	...	...
Lengths of secondary series in miles	90	60	...	150
Area of secondary triangulation in square miles	1,099	619	...	1,718
Do. embraced by triangulation to prominent points exterior to principal triangulation and in square miles	296	3,035	...	3,331
Number of points fixed by intersection, but not visited	65	107	...	172
Do. stations and points, the heights of which have been determined	57	121	...	...
Do. pillars, platforms, or posts for secondary stations, constructed or repaired	2	11	...	...
Do. miles of rays cleared	...	...	...	...
Do. do. pathway cleared	...	...	...	...
Do. hill tops cleared of forest and jungle	3	...	...	...
Do. Secondary stations, the elements of which have been computed	65	21	...	...
Do. points fixed by traverse, the elements of which have been computed	1	...	...	...
Do. miles leveled over, see para. 219	...	...	...	...
Do. permanent bench-marks fixed, see para. 219	...	...	...	...
Do. preliminary charts of triangulation	1	1	...	2

Summary of results of the work of the TOPOGRAPHICAL

TRIANGULATION.

Scale of Survey.	Topographical Survey.	Area triangulated in square miles.	Number of stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	1st class, or those in which each angle is usually observed on four zeros, or more.					2nd class, or those in which each angle is usually observed on two zeros.					3rd class, Tertiary, or those in which two angles only of each triangle are observed.				Number of extra heights determined by Barometrical observations or otherwise.
						Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	
4 inch = 1 mile.	No. 6 Topographical Party, Khasi and Garo Hills .	150	3	...	...	...	...	...	...	...	30	...	...	...	...	...	...	...	...	...
4 inch = 1 mile.	No. 7 Topographical Party, Rajputana . . .	690	37	5·8	10·7	...	...	...	...	...	38	202	6·7	0·63	34	80	136	1·93	30	...
1 inch = 1 mile.	No. 1 Topographical Party, Gwalior and Central India	270	7	4·2	8·4	...	...	...	...	...	2	20	3·5	0·09	1	63	112	0·5	31	...
1 inch = 1 mile.	No. 5 Topographical Party, Bhopal and Malwa . .	1,019	63	4·9	7·9	...	...	...	...	...	28	50	3·9	0·31	28	177	354	1·0	116	...
1 inch = 1 mile.	No. 8 Topographical Party, Mysore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	299
2 inch = 1 mile.	No. 2 Topographical Party, Khandesh and Bombay Native States . . .	1,231	74	2·8	6·7	...	...	...	...	...	56	142	12·4	0·50	56	397	696	1·3	132	184
2 inch = 1 mile.	Guzerat Party . . .	944	80	1·9	9·1	...	...	...	...	...	73	110	8·2	0·3	80	345	531	0·3	...	...
2 inch = 1 mile.	Kattywar Party . . .	1,350	63	2·8	12·2	...	...	...	...	...	56	107	12·1	0·6	41	462	813	0·7	78	.

PARTIES between 1st October 1879 and 30th September 1880.

Scale of Survey.	Topographical Survey.	Traverse.								Topography.			Names of districts, &c., through which the seasons' operations have been carried.	Area of Triangulation in advance of Topography.
		Instruments used.	Number of Stations at which the Theodolite was set up.	Linear miles simple traversing.	Linear miles Boundary Survey.	Average angular error per Station in seconds.	Average error per 1,000 links in links.	Number of village trijunctions fixed.	Number of plane-table points fixed.	Final Topography completed during the season in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test line run.		
4 inch = 1 mile.	No. 6 Topographical Party, Khasi and Garo Hills . .	...	...	...	...	...	...	...	...	220	0·7	...	Hill Tipperah.	
4 inch = 1 mile.	Ditto ditto . .	...	...	220	...	...	...	...	...	210	0·3	...	Sylhet District and Hill Tipperah.	350
4 inch = 1 mile.	No. 7 Topographical Party, Rajputana	...	...	...	...	...	...	...	...	6,924	2·1	...	Bickaneer	8,000
										7,138				
1 inch = 1 mile.	No. 1 Topographical Party, Gwalior and Central India .	...	...	...	...	...	...	...	...	1,287·4	13·4	3	Idar, Oodeypore, Mahi Kanta, Jodhpore	,913
1 inch = 1 mile.	No. 5 Topographical Party, Bhopal and Malwa . . .	...	...	...	...	...	...	...	...	1,408	11·9	43·7	Bori, Gwalior, Indore, Jhabua, Jobat, Rajpur Ali, Rutlam, Saibana	2,811
1 inch = 1 mile.	No. 8 Topographical Party, Mysore	...	4,410	250	...	...	...	...	...	2,099	7·9	...	Shimoga, Hassan, Kadur . .	16,800
										4,794·4				
2 inch = 1 mile.	No. 2 Topographical Party, Khandesh and Bombay Native States	6″ and 5″ Theodolite	2,050	1,151	...	5″	0·49	753	2·5	827·4	33	131·8	Khandesh .	2,930
2 inch = 1 mile.	No. 6 Topographical Party, Khasi and Garo Hills . .	...	...	260	...	...	...	...	...	102	6	...	Sylhet District	277
2 inch = 1 mile.	Guzerat Party	6″	3,258	794·9	217·5	17″	1·6	...	395	1,057·7	25·9	598	Ahmedabad, Broach, Surat, Baroda, Maha kanta, Rewa Kanta . .	1,030
2 inch = 1 mile.	Kattywar Party	5′	2,741	797	426·8	15″·9	1·7	...	...	2,133	12·6	296	Okamandal (Baroda), Cutch .	1,450
										4,120·1				
4 inch = 1 mile.	Guzerat Party	6″ and 5″	...	...	...	...	...	...	...	117·17	54	4·5	Dang Forests (Khandesh).	
6 inch = 1 mile.	No. 5 Topographical Party, Bhopal and Malwa . .	...	...	...	...	...	...	...	...	8·34	...	5·1	Dhar City.	
12 inch = 1 mile.	No. 7 Topographical Party, Rajputana	5″ omnimeter.	6	7·02	...	...	·25	...	...	7·6	...	...	Bickaneer City.	

Summary of the results of the field work of the REVENUE BRANCH

Designation of survey party.	Scale of survey.	Where employed.		No. of villages.	Area completed.		
		Province.	District.		Topography and Detail.	Traversing In advance.	Triangulation In advance.
					CADASTRAL SURVEYS.		
					Sq. miles.	Sq. miles.	Sq. miles.
No. 4 Party	16 inches = 1 mile	North-Western Provinces	Ghazipur	1,524	617	399	...
„ 5 „	Ditto	Ditto ditto	Banda	4	19	...	...
			Mirzapur	805	422	117	...
„ 6 „	Ditto	Ditto ditto	Jaunpur	1,371	525	316	...
„ 2 „	Ditto	British Burma	Hanthawaddy	294	763	245	...
„ 8 „	Ditto		Bassein	188	346	504	...
		TOTAL OF	CADASTRAL SURVEYS	4,186	2,692	1,581	...
					MAUZAWAR SURVEYS.		
No. 1 Party	4 inches = 1 mile.	Punjab	Dera Ismail Khan	51	1,335	1,934	...
			Rawalpindi	187	410	...	450
„ 3 „	Ditto	Ditto	Karnal	...	80(g)	...	...
	Ditto	North-Western Provinces	Muzaffarnagar	...	53	...	...
			Meerut	...	24	...	...
„ 5 „	Ditto	Ditto ditto	Banda	15	51	...	...
„ 7 „	Ditto	Bengal	Pooree	...	125	...	...
	32 inches = 1 mile		Ditto	...	40(f)	39	...
		TOTAL OF	MAUZAWAR SURVEYS	253	2,118	1,973	450
					TOPOGRAPHICAL SURVEYS.		
No. 3 Party	2 inches = 1 mile.	North-Western Provinces	Muzaffarnagar	...	1,140	...	...
			Meerut	...	381	1,256	...
			Ahmednagar	...			
„ 10 „	Ditto	Bombay Presidency	Poona	...	1,995	475	2,520
			Tanna	...			
			Colaba	...			
„ 11 „	Ditto	Ditto ditto	Sholapur	...	2,028	576	1,008
			Akalkot State	...			
		TOTAL OF	TOPOGRAPHICAL SURVEYS	...	5,544	2,307	3,528
			GRAND TOTAL	...	10,354	5,861	3,978

ABSTRACT ACCORDING TO JURISDICTIONS.

Province.	Scale of Survey.	Area surveyed in square miles.	Cost inclusive of contingent expenses.	Average rate per square mile.	Remarks.
			Rs. A. P.	Rs. A. P.	
North-Western Provinces	2-in. = 1 mile	1,521	47,616 9 9	31 5 2	
	4-in. = 1 mile	128	4,235 0 0(j)	...	(j) Exclusive of cost of 51 square miles of 4 survey in district Banda.
	16-in. = 1 mile	1,583	2,93,408 15 10	185 5 7 (k)	(k) The rate is inclusive of cost of Banda mapping.
Punjab	4-in. = 1 mile	1,825	69,262 6 0	37 2 8 (l)	(l) The rate is exclusive of cost of 80 square miles of river survey in district Karnal for which no separate rate is available.
Bengal	4-in. = 1 mile	125	55,666 6 9(m)	...	(m) Expenditure includes the cost incurred in bringing up records of previous season's cadastral survey.
	32-in. = 1 mile	40			
Bombay	2-in. = 1 mile	4,023	1,07,125 11 4	26 11 3	
Burma	16-in. = 1 mile	1,109	3,21,789 5 0	290 2 7 (n)	(n) The rate is enhanced owing to this being the first season of operations in Bassein district.
TOTAL	.....	10,354	8,99,434 6 8	...	

DEPUTY SURVEYOR GENERAL'S OFFICE,
Calcutta, 1st October 1880.

PARTIES between 1st October 1879 and 30th September 1880.

Designation of survey party.	Total cost.	Rate.	No of fields.	Average size of fields.	Remarks and References.
	Rs. A. P.	Per acre.		Acre.	
No. 4 Party	97,742 7 5	0 3 11	610,000	0·65	(a) Expenditure is inclusive of cost of completion of records of previously surveyed purganas.
„ 5 „	23,561 3 11 (a)	...	4,953(i)	(i)	(b) These averages are exclusive of hill, jungle and river tracts.
	77,856 12 10	0 4 7	355,140	0·70 (b)	
„ 6 „	94,248 7 8	0 4 6	925,928	0·36	(c) First season's operations with a new establishment in a new district; the rate is consequently high.
„ 2 „	159,061 6 1	0 5 2	416,102	0·90 (b)	
„ 8 „	162,727 14 11	0 11 9(c)	194,121	0·75 (b)	(d) An assumed cost of Rs. 55 per square mile has been adopted for the 4" survey.
	615,198 4 10	0 5 8½(h)	2,506,844	0·68	(e) Expenditure included under head Cadastral Surveys.
		Per sqr. mile.			(f) Detached hills, surveyed in area under cadastral survey by Settlement Department.
No. 1 Party	64,862 6 0	37 2 8			(g) Area surveyed along the Jumna River.
	4,400 0 0	(d)			(h) The average rate exclusive of Banda and Bussein would be 4 annas 7 pies per acre.—*vide* notes (a) and (c).
„ 3 „	2,915 0 0	(d)			(i) Chiefly hills, consequently excluded from average.
	1,320 0 0	(d)			
„ 5 „	(e)	...			
„ 7 „	55,666 6 9(a)	...			
	129,163 12 9	37 2 5			
No. 3 Party	47,646 9 9	31 5 2			
„ 10 „	57,872 15 11	20 0 1			
„ 11 „	49,552 11 5	24 6 11			
	155,072 5 1	27 15 6			
	899,434 6 8	...			

DISTRICTS COMPLETED SINCE LAST REPORT.

District.	Scale of survey.	Area in square miles.	Cost inclusive of contingent expenses.	Final rate Per sq. mile.	By whom and when surveyed.	Remarks.
Bengal.			Rs.	Rs. As. P.		
Cuttack (Irrigation Tract).	32-in. = 1 mile	364	1,75,857	483 1 11 (o)	By Captain D. C. Andrew and Messrs. E. C. Barrett and H. B. Talbot in 1877 to 1879.	(o) Rate enhanced owing to small size of fields and limited area surveyed. The rate per acre is Rs. 0-12-1.
N.-W. Provinces.						
Saharanpur	2-in. = 1 mile	1,952 (p)	1,36,329	37 9 5	By Major W. H. Wilkins in 1877 to 1880.	(p) Inclusive of 22 square miles on 4-in. and 13 square miles on 6-in. scale. The area of Saharanpur District here given is exclusive of the area surveyed by the Forest Department.
Muzaffarnagar	2-in. = 1 mile	1,675 (q)				(q) Inclusive of 63 square miles on 4" scale.

J. SCONCE, *Lieut.-Colonel,*
Deputy Surveyor General.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report, dated 24th September 1880, *of* LIEUTENANT-COLONEL B. R. BRANFILL, B.C., *Deputy Superintendent, Survey of India, in charge Madras Party.*

ON the cessation of the autumnal rains, the Madras Party proceeded to take the field, leaving Bangalore early in November, and reached the scene of operations by the end of the month.

I directed Mr. Potter to complete the remaining portion of the approximate series near Madras—selecting two of the final stations with special reference to their suitability for circumpolar azimuth observations, as near to the Madras observatory and to the sea as possible—and to build the necessary stations. At the same time Mr. Bryson was to devote himself to building the stations and clearing the rays immediately in advance of the observing party until he should meet Mr. Potter, and the whole be completed.

I myself undertook the final observations with the 24-inch theodolite and commenced the observing at Kaniyanúr H. S. on the 5th December, and continued without interruption, except from the long round-about marches, obliged by want of roads, and two or three bouts of rainy weather, until the work was finished at St. Thomas' Mount S. (the 15th station visited) on the 26th February, having fixed 13 new principal stations and closed upon two other previously fixed stations, common to the Madras Meridional and Longitudinal Series, Mâvandûr-Malaipêdu, by 16 triangles forming a hexagon and two pentagons, covering 2,001 square miles, and advancing the series from S.-S.-W. to N.-N.-E., a distance of 68 miles to its terminus at Madras.

1. Kaniyanúr H. S.	(north-west station of Polygon)	Ponnúr Hexagon.	8th Dec.	1879.
2. Narasingapuram H. S.	(west " ")		11th "	"
3 Chenji Rock S.	(south-west " ")		20th "	"
4. Perumukkal Rock H. T.	(south-east " ")		25th "	"
5. Ponnúr H. S.	(centre " ")		31st "	"
6. Mâvandûr H. S.	(north " ")		6th Jan.	1880.
7. Avirimédu H. S.	(north-east " ")		12th "	"
8. Tirumani H. S.	(centre " ")	Tirumani Pentagon.	17th "	"
9. Manamai-Kunnatúr S.	(east flank " ")		21st "	"
10. Pudupákam Mount S.	(north-east " ")		28th "	"
11. Malaipédu H. S.	(north-west " ")		4th Feb.	"
12. Mángád Mound S.	(north-west " ")	Nanmangalam Pentagon.	8th "	"
13. Nanmangalam Mt. S.	(centre " ")		13th "	"
14. Injambákam sandhill S., azimuth station	(east flank " ")		20th "	"
15. St. Thomas' Mt. S., azimuth station	(north " ")		26th "	"

Two sets of observations for azimuth were taken—at Injambâkam sand-hill on the coast line, 10 miles south, and at St. Thomas' Mount, 5·6 miles S.-S.-W. of the Madras observatory. Mr. Pogson, the Government Astronomer, was unwilling that an azimuth should be observed at the observatory, by which he thought his own pressing work would be retarded; and, notwithstanding Mr. Potter's earnest endeavours, no other suitable point could be found nearer than St. Thomas' Mount for an azimuth station, without incurring a heavier outlay in money and time than the object seemed to justify, the whole of the ground in and around the City of Madras being covered by lofty trees and private houses.

As soon as Mr. Potter had completed the approximate series, about the middle of January, I directed him to proceed with all speed to examine the ground between Pondicherry and the east flank of the series, as he was already well acquainted with the latter, having selected the east flank stations himself the year before last. He very soon submitted what appeared the most simple and feasible project for connecting Pondicherry with the principal triangulations. He then moved on without delay to the larger and more important work of connecting Negapatam with the main series near Kumbakônam.

In this task he succeeded to my satisfaction, taking advantage of the lofty towers of the temples, by which alone the task could have been accomplished during the season.

The spires or gateway towers of South Indian temples, commonly called *gópurams*, are tall, ricketty brick structures, consisting of an oblong basement, usually of stone, pierced for the gateway, surmounted by a pyramidal spire of many storeys, tapering up to a narrow ridge, and profusely covered with stucco ornaments. They are seldom or never used except by bats and vermin, and the many floors or stages within them have been allowed to fall in, so that access to the summit is dangerous, and, when attained, it is quite unsuited to observe from with a theodolite. Mr. Potter displayed much ingenuity in overcoming these difficulties by means of temporary staging, long ladders, and a portable striding platform, which he devised and carried with him, and by means of which he was able to set up the 8″ theodolite on seven *gópurams*, and thus complete the series.

On completion of the final observations at Madras, I hastened by your directions to the west coast of the Peninsula, to effect a connection between Colonel Lambton's triangulation, brought up from Cape Comorin, through Travancore and Cochin to Ponâni, with the Malabar minor series, brought down from Mangalore to the same neighbourhood.

I had directed Mr. Mitchell to effect this connection when he was engaged on the latter series, but he failed to find Colonel Lambton's old station marks at Kurnád ("Koornaud") and Anangamala ("Annangamalli"). The station of Anangamala, however is identical with Colonel Lambton's point, and I believe that Colonel Lambton's station of "Koornaud" was at a point on the Kurnád hill, marked by a mound of earth, with which I have made a secondary connection. A more thorough connection has been now made by my finding station ⊙ marks at Ponmala ("Punmalli") and Alattúr ("Allatoor"),

as also an old station platform on Machât (" Muchaut ") hill, the centre of which I occupied. All three of the latter are probably nearly identical, if not quite so, with Colonel Lambton's stations, thus completing a satisfactory connection. It was now the end of March and the air so hazy as to be quite unfit for observing, but I determined to take the opportunity to effect a further connection with the tranigulation of the Nîlgiri hills.

When in charge of the Great Arc Series (in 1869-70), at the instance of the Surveyor-General, I was requested to determine points on the Nîlgiri hills to form a base for Colonel Saxton's minor triangulation, which I accordingly did; but, owing to the length of the rays and the hindrance from cloudy weather, I was not satisfied with the results, though they were the best obtainable under the circumstances.

I am sorry to say that, although I spent about a month upon this work, in very trying weather, I was not very successful, chiefly owing to the sickness and consequent absence of my signalmen; still a connection has been made, and I think, from the approximate reduction that has been computed, it tends to show that my fears about the points laid down in 1869-70 were excessive.

After a circuit of some 700 miles, from Madras to Bangalore, thence by the Great Arc to Cape Comorin, and back by the East Coast Series *vid* Râmnâd to Madras, the series has closed with a small cumulative error in latitude and distance, but with a larger one in longitude, azimuth, and height.

The mean closing error in		latitude	is	0″·008 or about one foot.
,,	,,	longitude	is	0·262
,,	,,	azimuth	is	9·212
,,	,,	height	is	17·3′
,,	,,	distance	is	0·72′

the latter being equivalent to 0·027 feet, or one-third of an inch per mile.

This amount of closing error is perhaps no greater than might have been expected. Indeed, considering the extent of unfavourable country traversed, I anticipated a much larger.

Extract from the Narrative Report dated 5th November 1880, *of* CAPTAIN J. HILL, R.E., *Officiating Deputy Superintendent, 1st grade, in charge of the Eastern Frontier Series.*

I LEFT Bangkok on the 29th January, and next morning reached the small town of Phrapatom, where I had arranged to meet Mr. McCarthy, who was working in its neighbourhood.

He arrived about noon, and I had the satisfaction of learning that he had pressed on the work well during my absence. I may here remark that the Siamese, although they wish for telegraphic communication with British Burma, do not seem to care about rapid postal communication in Siam. For example, although Phrapatom (which is distant, as the crow flies, 30 miles from Bangkok) can be reached through the creeks in 12 hours, a letter I wrote to Mr. McCarthy from Bangkok on the 15th January (the day after my arrival), and which the authorities professed to send by express messenger, only reached him on the 30th, as he came into the town of Phrapatom to join me. After a few instances of such delays, I employed my own men as letter-carriers The Siamese appear to have no conception of the value of time, and our chief difficulty consisted in overcoming their dilatoriness. They thought (and indeed appeared to hope) we should find it impossible to extend our triangulation into Bangkok across the 30 miles of flat, wooded, and swampy country lying to the west of the city, and they were languid, to say the least, in their operations to assist us. I am glad to say there were exceptions to the rule; and, as in my report on the previous season's work I had the pleasure of expressing my acknowledgments to the Governor of Kanbooree, so now I beg to acknowledge the assistance given by the Governors of Nakonchasee, Tacheen, and Paknand. Our thanks are due to those gentlemen for their help and their hospitality. If the Assistant Governors and other minor executive officials with whom we came in contact had been equally attentive to our requirements, the work would have progressed all the more rapidly.

During my short stay in Bangkok the weather had once or twice been clear enough to enable me to get a good view of the surrounding country from an artificial eminence called Phookhow Thong, which is ascended by external winding flights of stone steps and is surmounted by a small pagoda, and which is the highest point of vantage in or near Bangkok. From this raised position I was able to obtain the magnetic bearing of the Great Pagoda of Phrapatom (the largest in all Siam), upon which I had placed a station the previous season; and I also, while searching the western horizon with the telescope, noticed, in a fortunate break in the far distant jungles, an object which appeared to me too thick to be the trunk of a palm tree, and which seemed to be more like a pillar or factory chimney. I accordingly noted its bearing, &c. It appeared to be from 15 to 20 miles distant, and to lie in a south-easterly direction with respect to Phrapatom. I had heard there was a tall chimney belonging to a ruined sugar factory near Nakonchasee, but it was supposed to lie more to the north. On going to Phrapatom I was fortunate enough, after some time, to identify the object I had seen through the telescope at Bangkok, and which could only be distinguished at Phrapatom when the sun

fell upon it in one direction. It turned out to be the old sugar factory chimney after all, the height of which from the ground I afterwards measured and found to be 83 feet. The problem of how to carry the triangulation into Bangkok was thus solved. I caused a huge bamboo scaffolding to be erected round the chimney, and a timber platform with an arrangement for insulating and centreing the theodolite to be constructed and placed on the top, and our observations were duly taken there. The height above the ground of the stations forming the last triangle of the Bangkok Series are all considerable. The height of the chimney has just been given. The height of the Bangkok mark stone at Phookhow Thong is 110 feet according to aneroid observations of mine, and 115 feet by Mr. McCarthy's measurement of the steps leading up to it. The station I placed the previous season on the Phrapatom Pagoda was exactly 100 feet above the ground, while a station Mr. McCarthy subsequently caused to be placed at a higher level, in order to avoid ray clearing (which with local labour would be an endless undertaking in Siam) is only 32 feet below the top of the spire, the altitude of which I carefully measured the previous season, and found to be no less than 347 feet above the mean level of the ground at the base of the pagoda. The height of 347 feet is that of the top of the masonry, and excludes the large metal ornament which surmounts the spire. Mr. McCarthy describes it as being nervous work climbing up the bamboo ladders to this lofty observatory. A pagoda being composed of one solid mass of masonry cannot be ascended from within. The ascent has to be made by means of bamboo ladders placed against it externally, and secured in position to iron pegs driven into the masonry. While the scaffolding round the chimney of the old sugar factory was being prepared, the ordinary observations of the lines were being carried on elsewhere by myself and Mr. McCarthy. It will be recollected that I reached Phrapatom from Bangkok on the 30th January. Throughout February and March there was a great deal of thick haze, much aggravated by jungle fires, which obstructed the observations considerably. The people also were in some instances inclined to be obstructive. In one instance they went so far as to stake with sharpened bamboos the path by which one of the signallers was accustomed to go for water from his station, and the man was badly wounded in the foot. In another they secreted some large timber posts I had ordered from Bangkok for the construction of a station near the village of Po Hak. This station, which was on flat, low, ground, had to be raised in order that observations might be taken between it and the chimney station. Mr. McCarthy was consequently obliged to make use of the trunks of some small palm trees which grew near; but after spending much time and trouble on the station, and clearing a quantity of trees and bamboos in the direction of the chimney, he was unable to open the ray. I was determined, however, that the chimney and Po Hak stations should be joined; and after a great deal of trouble, and the loss to us of much valuable time, the villagers, fearing they were about to get into serious trouble at Bangkok, suddenly gave up the missing posts to Mr. McCarthy, who quickly raised his station to the requisite height, and obtained his observations. Such occurrences as these, together with the dilatoriness of the officials and people, and the uncertainty as to the fate of any letter or message entrusted to a Siamese, constituted our chief difficulties.

Extract from the Narrative Report of MAJOR E. H. STEEL, R.E., *in charge No.* 1, *Topographical Party, Gwalior and Central India Survey, season* 1879-80.

Remarks on country triangulated.

THE triangulation only extended over 270 square miles; it was all very heavy ground, and mostly covered with dense jungle. Long parallel ridges running north-east and south-west are the principal features; there are one or two fine, though very narrow, valleys. The undergrowth and tree jungle to the west will give the plane-tablers much trouble.

Country plane-tabled.

The country plane-tabled was, with little exception, of a very difficult nature. Mr. Cornelius had in plane-table 186 a few square miles of flat ground near the Dhebar Lake bund, and Sub-Surveyor Abdul Aziz had to the south and west of his board a small portion of level country; but it was nearly all covered with scrub jungle and high grass. I should not omit to mention that the 120 square miles surveyed by Mr. Tate in standard sheet 94 were in fairly open country, with one high range of hills called "Saora" and a few isolated ridges dotted about.

A good deal of the country in standard sheets 88 and 90 is comprised of high mountain ridges with very steep slopes, and where the features die down into the lower ground, the drainage is exceedingly intricate. When I looked down from Sisa hill in March on the lower ground, the leaves were off the trees, and the under-features were visible; the land then looked like a petrified stormy sea.

The long ridges of precipitous hills are crossed at very rare intervals by passable passes; for instance, the Sam Ghata or pass is the only road passing from east to west in a run of 28 miles along the great ridge or backbone of the mountains which terminates on the Kulalia hill overlooking the village of Pol.

There were no forts, towns, or cities comprised in this season's work. The cantonment of Kherwara falls into the overlap of one mile, and will be surveyed and described by No. 5 party. The largest villages met with in standard sheet 88, were Madri, Juwass, Chawand, Babalwarra, and Rakhabdeo. This last contains a well-known Hindu shrine. The villages of Shodadur and Khed Brahma, of the Mahi Kanta agency, fall in sheet No. 90; the former is the property of a petty Rao.

Passes.

The Som pass is on the road from Kherwara to Kotra; the ascent from the Som valley is 700 feet, and the descent into the Maupore valley to the west is fully 1,000 feet. This pass is just practicable for lightly-laden animals; there is no other well-known pass.

Roads.

The main road from Oodeypore to Kherwara and thence to Ahmedabad runs through standard sheet No. 88; it is a fairly metalled road, is well bridged, kept in good order, and is quite practicable for all arms. A road has been traced from the village of Pershad, on the above-mentioned main road, to the Dhebar Lake bund, above which there is an old palace, now just repaired. A fair road has been made from Kherwara to Pola, and thence to Idar. This road is, however, fast falling out of repair. A good riding track, practicable for baggage animals, has been traced from Madri to Kherwara by the Madri Rao; it is six to eight feet wide. Lastly, the track from Kherwara to Kotra is called a road; it passes, as I have said some few lines back, over the Som pass.

Rivers.

The Sábarmati drains the country comprised in the western half of standard sheet No. 90; it forms many deep pools, but is fordable every mile or so during the cold weather, and in the rains, forms a stream 250 to 300 yards wide from bank to bank. The Som and Gomti, drain the country shown in standard sheet No. 88; the last-named stream receives the outfall of the Dhebar Lake. These two rivers join just south of the margin in the south-east corner of sheet 88.

Inhabitants.

The Bhils and Grassias have been described already; one point, however, struck me, which I do not think has been noticed before, namely the large size and fine look of the Bhil women relatively with the men. This point has, I believe, been noticed before in connection with some other predatory tribes.

Extract from the Narrative Report of Captain W. J. Heaviside, R.E., *in Charge No. 2 Topographical Party, Khandesh and Bombay Native States Survey, season* 1879-80.

The physical features of Khandesh are most pleasantly varied when compared with the dull monotony of the scenery in most Indian districts.

Khandesh cannot boast of snowy peaks or of the luxuriant vegetation of Lower Bengal; but the Satpura Hills are scarcely inferior, in point of scenery, to the lower ranges of the Himalayas. North of the Tapti River one meets with forests which, though not extensive, hold trees worthy to rank as timber with those of the Terai, while hard by, on the edge of these forests, the banks of the Tapti in the month of January are plains of waving wheat.

Khandesh has in addition all the best points of the Deccan: plateaux 1,500 feet above sea-level, not wanting in shady trees, where tent life is pleasant up to the end of April; ghâts of grand black precipices surmounted by columnar basalt in fantastic forms rising to a height of 4,000 feet; well-irrigated valleys of black soil growing magnificent crops of wheat and sugar-cane; uplands near the sources of the Pánjhra River, where there is pleasing woodland scenery, and the river, shadowed by fine old trees, flows over the rocks in rapids and pools where an occasional small *mahsir* may be tempted with a fly in the evening. As a contrast, there is the low-lying malarious country of the *Dángs*, with low hills almost concealed by grass jungle and tree forest—a country which is considered deadly to the European until February, and which, by that time, is so dried up that it is difficult to obtain decently good water; a country where an occasional clearing and a few Bheel huts are the only signs of habitation, but where the frequent call of the painted partridge somewhat compensates for all these disadvantages.

Such are the diversities of country lying west and north-west of Dhulia, that have been met with in the country plane tabled this season, within a few days march of each other, and within an area of 30 miles of longitude by 70 of latitude; but the chief portion of the work executed embraced the whole upper portion of the Pánjhra Valley.

The Pánjhra Valley.—The Pánjhra River rises in the Sáhyádri Hills, about—

Latitude	...	...	...	...	...	20° 45′
Longitude	...	...	...	...	...	74° 0′

and for the first 15 miles of its course flows eastwards through an upland country nearly 2,000 feet above sea-level. The fine old mohwa and mango trees grouped about the borders of the river and its tributaries—the large, undulating expanses of grass, broken here and there by patches of wheat round a group of Bheel huts, or by low hills clothed with tree jungle—make up a pleasant sylvan scene, which is green and refreshing to the eye even in April, and is rendered all the more striking because in such marked contrast to the severe black basaltic precipices and peaks which form a background to the south.

The uplands are but sparsely inhabited; there are no large villages; Bheel huts are scattered about here and there near the patches of cultivation, or near water, as the latter becomes rather scarce towards the end of March, except in the main stream.

The bed of the river in these upper reaches alternates between sand and rock, with a considerable fall averaging 30 feet a mile, the water here and there cascading over the rocks.

Pimpalner, the taluka town, is the first place of any importance on the river, and although out of the upland country, is nearly 1,700 feet above sea-level. It is a poor looking place of about 2,500 inhabitants, but there is a considerable expanse of well-irrigated black soil round about it, and from a few miles above Pimpalner the flow of the river is perennial.

From Pimpalner to Dhulia (50 miles) the river still flows eastwards; its bed is of rock throughout, with the considerable fall of 830 feet in this distance, or about 17 feet a mile. The river is thus eminently suited for irrigation purposes, and, from some distance above Pimpalner, masonry dams, often having the appearance of being 100 years old, stand across the river at every three or four miles, the water being led off in wide channels to irrigate large tracts of black soil, in which magnificent crops of sugar cane and wheat are grown. This ground appears never to be left fallow: no sooner is one crop off the ground, than the land is ploughed and a new crop sown, wheat and sugar-cane generally alternating; and in a good year, such as this has been, the sugar-cane mills are in constant work, day and night, for some six weeks, in all the villages on the banks of the river.

The chief tributary of the Pánjhra is the Kán, which joins the river about 28 miles west of Dhulia. The basins of these rivers extend from the narrow, lofty range of hills on the south, dividing Khandesh from Násik in about latitude 20°-45′, to the high table land to the north, on which the Kundabáiri Ghát and Bhámergarh are situated, in about latitude 21°-7′, and is bounded to the west by the Sáhyádri Hills, which overhang the Dáng country near the meridian of 74°.

The Mangya Tungya Hills.—This narrow rocky range, which runs east and west near latitude 20°-45′, separating Khandesh from Násik, is a spur of the Sáhyádri Hills, and has all the marked characteristics of the trap formation, such as fine black precipices, three and four hundred feet in height, while the peaks of the hills rise from three to four thousand feet above sea-level, in masses of columnar basalt which frequently takes the most fantastic shapes, resembling buildings and monuments on a Titanic scale.

The two most remarkable hills of the range are known as Mangya Tungya, and are about three-quarters of a mile apart. Rising some 2,500 feet above the Pánjhra Valley, they are visible from very long distances, and a near approach to them impresses one with their massive grandeur.

From the south, or Násik side, these two hills rise in quadrangular pyramidal forms, with rocky precipitous sides, stepped at intervals to a height of 1,500 feet above the plains. They are here connected by a narrow saddle, the southern face of which is a precipice having the appearance from below of a wall of black rock some 400 feet high. At either end of the saddle the hills still rise some 550 feet higher, the pyramidal forms being more strongly marked than they were below, and more frequently stepped, till each culminates in a column of basalt 200 feet in height. It is difficult to imagine anything in nature more typical of the monolith rising from a pyramidal base, with which architects have made us familiar. But here the scale is colossal, and so much the more magnificently grand.

The basaltic columns which form the summits of these hills are quite inaccessible. A terrace, partly natural, partly artificial, has been formed round the western one, which on the south side is only just wide enough for a single man to pass along, but on the north side is about 10 or 12 feet wide and 330 feet long. On this side five temples, or rather *chatris*, have been built in the shadow of the rock. There are also on this side three temples and two water-tanks, all excavated in the rock. These three rock temples appear considerably older then the *chatris*, and may originally have been commenced by Buddhists; but the inscriptions, as well as the character of the figures and ornament, show that they were finished or converted by Maráthás.

The face of the rock above the terrace is studded with figures of gods and goddesses of various sizes—altogether, within and without the temples, 400 figures were counted.

There are two ways up the hill, on both of which a number of steps are cut at intervals, where the rocks are most precipitous, and without these steps, or the use of ropes, an ascent to the temples would be impracticable. I ascended by one route and descended by the other. I did not count the steps going up, but in coming down there were 570; most of them were cut out of the solid rock, and some were built up, with here and there a low parapet wall, and at the corners, where the steps zigzagged, one rather failed to appreciate the grandeur of the precipice below. Near the bottom of the hill there are two small, rock temples, evidently Buddhist, in fair preservation. Altogether a vast amount of labour has been expended on this hill, which appears to be worth the notice of the Archæological Survey.

Pisul Hill.—Pisul is another hill in the same range, with a history. Standing 1,500 feet above the surrounding country, its sides are as precipitous as those of Mangya Tungya, but its summit is a plateau about half a mile long by a quarter in width, and is a natural fortress.

Such a combination in nature seems seldom to have escaped the eye of the predatory Maráthá. He would be as safe there from any ordinary attack as the eagle in his eyrie, and could swoop down at pleasure on the dove-cots below.

The only approach to Pisul is by a narrow gorge on the south side of the hill. This was protected by several cross-walls, the ruins of which still remain. In the rocky sides of this gorge, store-rooms and water-tanks are excavated. Water is still deposited in considerable quantities in the latter, but is much fouled by bats. There are also catchment basins for water in suitable spots on the top of the plateau.

Notwithstanding the precipitous nature of the hill sides, it appears that the edge of the plateau was still further strengthened by walls here and there. There is but one

building remaining—a small house which is still in fair order. The Mahomedans have left their mark of supremacy in a fine gothic archway, standing erect amidst the debris of old walls and houses.

Towns.—Mr. Horst, in last year's report, described most of the *taluka* towns in this season's work; and in referring again to some of these I shall be careful to avoid repetitions.

Nandurbár—latitude 21°-22′, longitude 74°-17′, population 7,000—is situated between two low ranges of hills, which nearly surround it. The position from a sanitary point of view is about as bad as it could be. The site was probably selected with a view to protection from incursions, as the numerous old remains of walls along the hill-tops tend to prove; but as water is very scarce within these limits, the site could hardly have answered this purpose well. Fifteen *per cent.* of the inhabitants are Mahomedans—a decaying remnant of the descendants of the Mogul dynasty. Their principal mosque—the shrine of Sayat Sháhádawa Alladin, who was killed in a battle near Nundurbár—stands on the western extremity of a low range just outside of, and about 70 feet above, the town, and forms an admirable landmark for miles around. It is of good proportions, and overlooks a fine tank, on the embankment of which there are thick groups of large *banyan*, *semel*, and tamarind trees, while in the cold-weather the waters are well covered with fowl, and under certain aspects this combination is eminently picturesque. The mullas of the mosque, who state they are very poor, instead of whitewashing the mosque with brushes in the ordinary way, have adopted the cheaper plan of dashing the whitewash in pailsful over the building. The result is that the arched recesses, the cornices, and the general tracery of the mosque, are fringed with stalactites producing a most pleasing and artistic effect, suggestive, even in the warm sunshine, of snow and icicles.

A considerable quantity of teak timber passes through Nandurbár, about 4,500 cart-loads paying octroi duty annually. On one market day I saw as many as 400 cart-loads, but this is an unusual number. A cart-load sells at about Rs. 7 to Rs 15; thin poles cost 4 annas each; those about 15 feet long and 6 to 8 inches in diameter, Rs. 2-8 each; and timber from which beams 9 or 12 inches square could be cut, cost about Re. 1 a cubic foot. This timber comes chiefly from the Ságbára estate, north of the Tapti.

A good deal of timber is employed in the construction of the houses in Nandurbár, many of which are substantially built of two stories, with tiled roofs. The woodwork is generally carved, sometimes elaborately, and nearly always with very good taste, by men from Guzerat.

A large trade in wheat has been done this year by *Banjáras* between Nandurbár and Surat, the harvest having been very plentiful throughout Khandesh. The married *Banjára* women adopt a fashion hereabouts, which I have never seen elsewhere: the *sári* is worn hanging down over a piece of bamboo about 18 inches long, projecting from the back of the head, thus having rather the appearance of a fool's cap, and resembling the steeple cap worn by ladies in England towards the end of the 15th century.

The taluka town of Pimpalner and the petta town of Nizámpore are insignificant in size, and with nothing remarkable about them.

Balsána Temples.—At the small village of Balsáua, about ten miles north-east of Nizámpore, there are several small temples of a style known as hemádpáthi, built during the dynasty of the Gouli kings, which appear to have escaped the vandalism of sects and conquerors. Unfortunately they were built of stone (trap), not thoroughly crystalline, so the weather has played sad havoc with the external figures and ornament.

The figures in niches placed in a belt round the walls of one of these temples are 2½ feet in height, which is larger than I have seen before on a temple of this style, and many of these figures are in fair preservation. The interior of this building is small, the height from the floor to the top of the dome being only 15½ feet, but it is in excellent preservation. The figures are unmutilated, and, blackened as they are by the action of time and of colonies of bats, harmonise well with the simplicity of the ornament on pillars, cornices, lintels, and jambs, which, again, are in such perfect keeping with the straight lines of the massive pillars and corbelled stonework, as to remind one strongly of Greek art. This little temple is quite a gem, well worthy of the attention of the Archæological Survey. It is at present devoted to the popular Hindu god *Lingum*, but has escaped the desecration of red paint.

Manufacture of Catechu.—Small encampments of Bheels are not unfrequently met with in the forests, engaged in the manufacture of catechu, which is chiefly sold to chew with the pán-leaf by natives. The superintendent of the manufacture was generally a *bunya* who paid a small royalty to Government. The process is simple. Chips are cut from the heart of the *khair* tree, and stewed in small pipkins for several hours; a turbid, orange-colored fluid is thus produced, depositing a substance the color and consistency of thick strawberry cream. This is subsequently dried in the sun, and breaks up into pieces much like nodules of dark red earth. In this form it is sold in the bazars

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General description of the country triangulated by Mr. A. G. Wyatt, *Surveyor, Fourth Grade, Khandesh and Bombay Native State Survey, season* 1879-80.

The triangulation of the past season comprises a portion of Khandesh lying between the meridian $\frac{75°15'}{74°45'}$ and south of latitude 21°-0′ and up to Hydrabád boundary. Starting from the side Sátmála to Walwári, a series of secondary triangles was run westwards, closing

on the side Danwar to Sirsála, both of the Khanpisura series of the Great Trigonometrical Survey.

The triangulation embraces portions of the following talukas:—Pachora, Erandole, Jamner, and Nasirábád of the Khandesh district. Of this tract three-fourths may be said to consist of well-cultivated country, and about one quarter of low, undulating hills. That to the south of Nasirábád and on the right bank of the Girna river consists of low hills rather thinly covered with babul and brushwood. The table-land of Dhanor, on which is situated the Great Trigonometrical Station of Danwar, lies about ten miles south of Nasirábád village. It is about 12 to 14 miles in extent. The fall to the north and east is very gradual; that to the south and west abrupt, the fall measuring about 700 feet. The portion to the west of the Girna, and between that river and longitude 74° 15′, with the exception of a small range of hills lying three miles south-east of the town of Erandole, called the Powarthála plateau, is well cultivated, and consists of numerous, large and well-inhabited villages. The country south of Pachora and along the Waghur valley is also well-cultivated. To the north of Bhargáon and east of Argaon villages is a low range of hills running north and south, on which is situated the Great Trigonometrical Station of Walwári.

The chief rivers passing through the portion triangulated are the Girna, Waghur, Anjni, Titur, and Hiura. The Girna, the largest of these, flows eastwards by the large village of Bhargáon; it then turns northwards and flows through the low country and plain into the Tapti in $\frac{\text{Lat. } 21°\text{-}8'\text{-}30''}{\text{Long. } 75\text{-}21\text{-}30}$. The Titur and Waghur, Anjni and Hiura, take their rise from the high range of hills separating Khandesh from the Nizam's dominion. The Waghur flows northward by the villages of Páldhi and Pohar, and is a running stream throughout the year. It is a tributary of the Tapti. The Titur and Hiura join the Girna—the former about two miles east of Bhargáon village and the latter north of Bholeswar and east of Utran villages. The village of Bholeswar is situated at the junction of the two streams.

Erandole and Pachora are the chief towns of the talukas of those names. The former is situated on both banks of the Anjni and on the high road between Málegaon and Bhusáwal; the latter is a smaller village, but is well known on account of the railway passing through it. It is situated on the left bank of the Hiura.

Bhargáon village is situated on an island in the Girna river. It is about six miles west of Pachora. A good metalled road connects the two villages. Bhargáon is a peta or sub-division of Pachora taluka.

The products of the country triangulated are of various kinds. The soil in the plain is extremely fertile. It is a rich, black clay. On the hill tract every available spot is cleared and brought under cultivation.

From Dhulia, the capital of Khandesh, there is a high road going east to Jamner, and passing by the villages of Parola, Erandole, and Musáwad. Another road from Dharangáon meets this one a few miles east of Erandole. Both these roads are bridged the whole way.

Starting from Nasirábád there is another metalled road going south to Jamner, which passes over the Dhanor plateau and descends two miles north of the village of Neri. The road from Dhulia to Jamner, already described, meets this one half a mile west of Neri village.

Extract from the Narrative Report, dated 3rd November 1880, *of* Lieutenant-Colonel C. T. Haig, r.e., *Officiating Deputy Superintendent, 1st grade, in charge Guzerat Party.*

On reference to the accompanying index chart it will be seen that the Sábarmati crosses sheet 5 from north to south, and that the Háthmati joins the Sábarmati in this sheet. All west of the Sábarmati is Baroda territory, and with the exception of one British village, all in the fork of the two rivers is Máhi Kanta territory; and, excepting one Máhi Kanta village, all south of the Háthmati is British territory. The greater portion of the adjoining plane table of sheet 24 is British; the remainder is Máhi Kanta.

The banks of the Sábarmati and Háthmati rivers were great obstructions owing to their being broken up, sometimes to a distance of a mile from the river into a reticule of precipitous, tortuous ravines. The watershed west of the Sábarmati lies very close to the river, from less than one mile up to three miles from it; and west of the watershed the country falls very very gently down to the Runn of Cutch. The Sábarmati flows between steep banks, nearly 100 feet high, and the general run of the watershed is only a few feet higher than the top of the banks; and so, although the drainage slope is so narrow, it has but a gentle declivity. West of the watershed the country is in many parts very undulating; but the features are without any regular formation, and could only be properly shown by rigorous contours. The drainage is so precarious that there are large areas which are really not drained at all; but in a copious monsoon the tanks are enlarged into lakes, called "Bharits." On account of this lack of drainage the drinking-water is bad, and in the hot weather it becomes so impregnated with saline matter that it is deleterious to health.

The country of sheet 5 is fairly populous and well cultivated, parts of it are woody; but the trees, though no hindrance to the cultivation, are to surveying; and there is an area of about 200 square miles over which there is no triangulation, but which had to be prepared for final survey by traversing; and therefore over this area there are no heights, but as the country is very flat their absence is not a very serious matter.

The principal towns in sheet 5 are Visnagar, the head quarters of a taluka, or, as it is styled in Baroda territory, a máhal and a post town where there is a Wainatdar or Mamletdar. It has a population of nearly 21,000, and in the same máhal, Walan and Wasai with populations respectively of 5,940 and 5,125: the post town of Vijapur, the head quarters of another máhal, with a population of 8,880, and in this máhal Ládol, with a population of 4,632. Besides these there are in these two máhals 20 towns with populations ranging between 1,500 and 3,000.

On the banks of the Háthmati is the post town of Ahmednagar, once a fine city but now a town, with a population of 4,461. The walls are still in a sound state, though considerably out of repair. It was built by Ahmed Shaw in A. D. 1426, and is a place of considerable historical interest. It now is part of Edar, the principal of the Máhi Kanta States. There is a broad straight road from Edar (in sheet 23) to Ahmednagar, and thence through Paránty to Ahmedabad. Just above the city of Ahmednagar there is a fine masonry bund built in 1875 by the Irrigation Department. It is 1,016 feet long and 64 feet high in the centre, and converts the river above it into a magnificent lake, several miles long, which supplies a canal that irrigates the country round Paránty.

In the fork between the Háthmati and the Sábarmati is the town of Ilol, with a population of nearly 4,000, the chief town of one of the Máhi Kanta States; and near the north-east corner of sheet 5 is a large Edar village, named Jádar, with a population of 1,600; but excepting these two and Ahmednagar, all the villages east of the Sábarmati in sheet 5, and in the one plane table of sheet 24, have populations under 1,500.

The country in sheet 33 and the south-west quarter of sheet 32 is mostly difficult ground to survey. It is very much cut up with watercourses, the most tortuous that I have ever seen; and as their banks are thickly wooded, their sinuosities could not be laid down by intersection, but compelled the plane tabler to follow them along their entire course, causing great delay. The average number of plane table stations per square mile of the respective plane tablers in sheet 33, ranges from 22 by Mr. D'Souza to 53 by Lakshuman Shitaram. In easy country I have had to insist on the plane tablers not having less than six per square mile, so that it will be gathered from this how intricate the ground was.

The drainage of sheet 33 is from east to west. The river Tapti, with its tributary, the Virakhári, the Kim, and the Amráwati, a tributary of the Narbada, are the chief watercourses. I have stated them in their order from south to north. The watershed between the Amráwati and the Kim is a well-marked elevation from almost any point of which a fine view of the country on either side is obtainable, but south of the Kim the country is hilly and jungly affording cover for tigers, of which one or two are generally killed there annually. The eastern half of sheet 33 is very unhealthy in the cold-weather, malaria being very prevalent, and it was therefore not commenced till the hot-weather; but there was also a good deal of fever among the native establishment working in the western half during the cold-weather.

The taluka town of Mándvi is in sheet 33, but as the sheet is not completed, I will give the details of the towns and their population in my next report. The south-west quarter of sheet 32 contains portion of the Ankleswar taluka of the Broach collectorate, a portion of Baroda territory, and part of the Rajpipla territory, one of the Rewa Kanta States. This will be published on the 2-inch scale, showing the British territory in detail and the Foreign territory in skeleton. The Bombay, Baroda, and Central India Railway crosses this section, the station of Ankleswar being on the northern margin, and Pánoli station near the southern and western margins. There are no large towns or villages in this section, the largest being Jitáli, with a population of 1,345, situated close to the northern margin, about the middle of the section.

Sheet 16 was also a very laborious piece of work. It is a small area, but it is important from its containing the large Gaekwári taluka town of Navsári, population 14,218, and the British taluka town of Jalálpor, population 2,188, which are close together on either side of the Bombay, Baroda, and Central Indian Railway. It also contains the railway station of Amalsád, and the Gaekwari town of Mora, population 3,528, with its adjoining village Bili, which together give the name to Bilimora railway station. Besides these there are the towns of Matwád, population 4,392; Abrama, population 3,566; Bigri, population 3,141; and seven villages with populations between 1,500 and 2,000, and, of course, many smaller ones.

Navsári is on the estuary of the Purna river, which admits of the largest native craft coming right up under the town. Into this estuary flow numerous creeks, and these and the muddy expanses through which they flow caused great trouble to the surveyors; but not more than the rest of the ground in the sheet, which was so broken and woody that it admitted of little sketching, but obliged the plane-tablers to put up their plane-tables as often as the ground in sheet 33. This will not appear to be exactly the case from the tabular statement of the detail of topography, where the average number of plane table stations per square mile ranges from 22 by Nilkunt Vithal to 35 by Wasadeo Gonesh, but these averages include the work on the mud, in which the number was less, than on the *terra firma*, though it was none the less tedious.

The country surveyed in the Dangs lies immediately south of that previously surveyed. It is as rough and wild as to its features as any yet surveyed, but it seemed more healthy and was more thickly populated than the country to the north. Malarious fever seems to vary in prevalance with the bamboo, and in this southern area there was less bamboo jungle than we have yet encountered. The surveyed area contains Wásurna, the chief

village in the Dangs of that name, but otherwise an insignificant place. The southern portion of the Dangs is much more capable of cultivation than the northern portion. In the northern portion forest clearances are scattered about the country, but in the portion surveyed this year there are many large areas which have been cultivated, though not nearly all the culturable land is taken up in any one year. The population may, I suppose, be taken as a measure of the actual cultivation, and the area under survey this year was much more thickly populated than the parts we have yet surveyed in previous seasons; but population seems such a very precarious item of Dang statistics, that I abstain from any definite statements. A village may be largely inhabited one year. One hundred and fifty is a large population for a village in the Dangs, and nearly or quite deserted next. There is a greater abundance of bamboo jungle in the northern than in the southern Dangs, and the bamboo seems to hinder cultivation. In comparing between north and south I refer only to the western half of the Dangs. In the eastern Dangs there are large open tracts more populated and cultivated than any we have yet met with in the topographically surveyed area.

The season's work in the Dangs is mostly confined to the valley of the Ambika (which, however, in the Dangs goes by the name of "Ibla") and its tributaries, the Deoldár and Pánetha. The Khápri valley also enters into the north-east portion. The Khápri flows into the Ambika, but outside the Dangs. The greatest height on the watershed between the Ibla and the Khápri in this season's work is Humbália Hill, 2,210 feet above the sea.

Extract from Annual Report on the operations of the No. 10 *Revenue Party, Deccan Topographical Survey, for season* 1879-80, *by* Colonel J. Macdonald, *Deputy Superintendent.*

The country surveyed to complete sheets 14, 18, and 22 is under the western aspect of the Ghâts, whose supporting spurs are built up in a series of plateaux cut up by innumerable deep ravines. The slopes are almost universally forest grown. Around "Kasgaon" there are a few square miles of open country. The hills bristle with the old hill forts, among which "Tungi" and "Rajmachi" are most noticeable

Amongst the streams which drain this western fall of the Ghâts, the "Kalu," which rises at "Harrichanderghur" and flows almost due west, is the greatest. The "Shai," which rises at "Ajuba," flows south and falls into the Kalu at Khapri. The "Khandeshi" and the "Chilar" rise on "Bhimashanker," near the village of "Tembri." On the banks of the "Chilar" is an ancient cave excavation; the open face entrance, 40 feet in width, is supported on two massive pillars with carved capitals cut out of the rock. The depth of the cave is about 21 feet. No trace of inscription exists.

The "Thul Ghât" incline of the Great Indian Peninsular Railway has been surveyed in sheet 14; also the old Agra road from Bombay which crosses the railway at several points. This is the only first class metalled road in that portion of the district. There is no available road for wheel traffic along the Ghâts between the "Thul" and the "Bhore Ghât" inclines of the Great Indian Peninsular Railway. A road over the "Malsej Ghât" is in course of construction; commencing at Callian it passes through "Murbad," following the old "Brinjari" track, and enters the rich valley of "Junnar" above the "Ghâts" in the Poona district. The "Nana Ghât" road, a few miles south of the new "Malsej Ghât" road in process of construction, is the next in importance; it is only adapted to pack-carrying animals. When the Mahomedan army that entered the "Deccan" arrived before Deoghur in 1294, they found outside the walls a vast number of bags of salt which had just been brought from the "Konkan" over the "Nana Ghât." At the top of the Ghât there is cut on the rock the oldest inscription which has yet been discovered in this part of India.

Salt was evidently then, as now, the chief article carried from the Konkan to the upper lands. There is also a pack bullock track over "Bhimasanker," but it is very little used as it is long and difficult. Coolies carrying head loads can scramble up and down the Ghâts here and there. The best foot track is up the hill side at "Kupoli."

The area surveyed in sheet 75 comprises talukas "Penn" and "Alibaugh" of the Colaba Collectorate, and a detached portion of the "Bhor State." The Ghâts here approach within thirty miles of the sea board. The intervening country is very rugged, crossed with ranges of hills, which in many cases are of considerable height, ranging from 1,000 to 2,500 feet. The slopes and intervening valleys are mostly covered with a strong growth, chiefly of teak. With the exception of the "Kharapet" lands around "Washi," and a narrow strip along the seaboard, the country is forest clad. The wild mango trees are especially grand as trees.

The facility for transport afforded by the numerous tidal creeks, which permeate these valleys very numerously, is taken full advantage of in supplying the markets of Bombay with wood and jungle-produce, amongst which the fruit of the "Hirda," known in trade as "Myrobolam," is chief. Rice is grown in vast quantities along the "Kharapet" lands, and full advantage is taken of every spot of cultivable land, in all the "Konkan" valleys and plateaux. Along the seaboard there is a dense vegetation in cocoanut, betelnut, and plantain cultivation. Fruit and vegetable gardens, also a great system of fish-drying, complete the industry of these thickly inhabited villages.

The "Amba" river rises under "Khandala Ghât" passes "Nagotna," where it is crossed by an ancient Mahomedan bridge below which it is navigable for vessels of 30 to 40 tons burthen. It extends as a tidal channel entering the Bombay harbour. On the banks of this

river, near the village of "Unheri," are situated two hot springs frequented by sufferers from paralysis and rheumatic affections. The temperature of the water is about 130° Fahrenheit. The water has a sulphurous taste. The flow is great and constant, there is never any palpable difference in the volume of water.

The "Bhagwati" rises at "Bondia Donger;" it passes the large town of "Penn;" and is navigable to a point about a mile and a half from "Penn" at the village of Antora, that is to say, it is navigable when it merges into a tidal creek.

General Description of the Konkan.

The Konkan may be described as the tract between the Ghâts and the sea, from latitude 20° 25′ north to the border of the Portuguese territory of Goa, a distance of more than 300 miles, and its average width is about 45 miles. Its area may be roughly estimated at 14,500 square miles.

The North Konkan is well wooded. It is intersected by many rivers and arms of the sea. Where there is arable land it is highly cultivated and very populous, but much of it is rocky and rugged.

North of Bombay and Salsette the general character of the coast is sandy and shallow. South of Bombay the coast is precipitous. Behind the rocky islands are deep tidal rivers which form commodious harbours. All along the coast the rocky eminences are crowned with forts, which of old played an important part in the long succession of wars which for centuries were continued between the Mahomedans, Portuguese, Marathas, and, during the early part of last century, the piratical hordes led by Angria.

It is only within the last few years that roads fit for wheeled vehicles, have been made in many of the districts south of Bombay. Only eight roads (one under construction) cross the great Ghât wall between the "Konkan" and the "Deccan" plateau. The Tanna Collectorate has roads through most of its talukas, and it benefits by the lines of railway which, commencing at Calcutta and Madras, meet at Callian.

The numerous rock excavations so common in the "Konkan" show that the Budhists had an influencial following here. In the island of Salsette they abound especially. The caves at Kanheri form so large a cluster, that they could afford shelter to many hundreds of people. The excavations amount to 102, but these do not represent all the immense labour expended on these rock-cuttings. Each group of caves has its separate reservoir outside; couches and benches are cut out of the rock. Across the slopes of the hills, steps are carved out for the convenience of intercommunication between the different halls and temples. Though greatly disappointed in the beauty of the caves, still I think they are worth visiting. It is supposed that their construction dates from about nineteen centuries ago.

Near "Kanheri" are the caves of "Mandapeshwar" and "Magathan;" these are "Brahmanical." The caves at "Mandapeshwar" were utilized by the Portuguese, who set up an alter in the large cave and used it as the crypt of a church built over the cave.

The caves at "Kuda" and "Mhar" are Budhist. Numerous small caves are found here and there. In these, as at Elephanta, the sculptures and inscriptions were destroyed and defaced by the Portuguese in the sixteenth century, when as partial iconoclasts they routed out the hordes of *jogers* who inhabited the caves.

There are but few remains of fine buildings showing the traces of Mussalman occupation. At Callian, where there is still a large Mussalman population, there is a fine mosque; and if its dome was in proportion to the rest of the building, it would be architecturally remarkable. It is situated on the edge of a splendid tank, round which are many tombs. In a rather large building is the tomb of Mortabha Khan, which dates from 1695 A.D. The fine old bridge at Nagotna, built in 1582, deserves notice; but as it is barely ten feet in width between the parapets, two carts cannot pass each other on it, and it would be almost useless for heavy traffic. It is strange that there are not more traces of a governing race which built like giants and finished like jewellers, considering that they attached considerable importance to the trade with Egypt, Persia, and Arabia, and that they were supreme in power from an early date in the fourteenth century to the close of the sixteenth.

Of the Maratha rule, dating from the middle of the seventeenth century, the great hill forts are left as their heaviest marks. Though some show traces of Mahomedan building, it is evident the Mussalman thought less of fortresses than the Marathas. All are constructed on the same principle. The top of the fortified hill is surrounded by a bastioned wall. If any outwork is necessary, it is connected by a carved passage with the body of the work. The gateway is always in the part most difficult of access. Some of these forts show results of stupendous labour in rock-cuttings. In all a small shrine dedicated to "Hanuman" is found inside the main gate.

Some notice should be given to the masonry built fort at "Khardeh" in the "Jamkhed" taluka. A square, enclosing about ten acres of ground, surrounded by lofty bastioned walls and a deep ditch with walled counterscarp. The walls are eight or nine feet in thickness at the top, and sufficiently thick at the base to admit of casements being built in them as shelter for the garrison. Inside the fort is a mosque built by "Sirdar Jehan Khan," killadar. The fort was erected, as announced on an inscription, on the outer doorway of the sally post: "In good time and in good days this building has been erected by Rajah Sultanji Nimbalkar, the Deshpandias, the Patels, and the Saukars of Kasba Sheopatan, pergunnah Jamkhed, Sirkar Ahmednagar, tributary to the Bádáshá Takte Buniyad (the Badshah of Aurangabad), and was completed on the 25th of Saban 1156, Hijiri," (1740 A.D.)

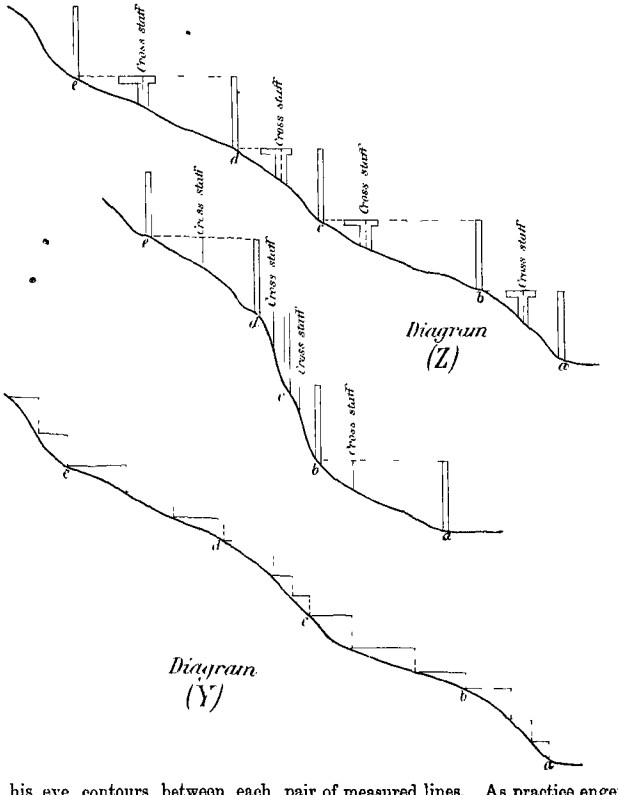
Khardeh itself is a town which was once the seat of a very important grain and salt trade, now deteriorated to one-fourth of its former value; and it is also noticeable as having been the scene of a great battle between the troops of the Nizam and the Peshwa in 1796, in which the latter were victorious and ever after maintained their supremacy in the eastern districts of Ahmednagar, until their authority passed into the British power after the battles of Poona and Kirki.

All this country shows denudation of its forest trees. Every effort is being made to promote jungle growth; but centuries must elapse ere the injury to the country caused by the folly and greed of one unthinking generation can be quite forgiven by nature. It is my opinion that the future of the eastern districts, as far as their agricultural prospects are concerned, is most gloomy; and it is certain that the rainfall in the upper basins of the Godavery and Krishna rivers will be most precarious for many years to come.

Extract from Annual Report on the operations of the No. 5 Revenue Party, Banda and Mirzapur Districts Survey, for season 1879-80, *by* COLONEL F. C. ANDERSON, *Deputy Superintendent.*

IT was impossible to employ European agency alone on the 93 square miles of hills surveyed on the 16″ and 4″ scales during the past field season; and as it is a work of time to train even the best native surveyors to judge degrees of slopes to ordinary accuracy, I devised the following plan by which to carry out, as far as practicable, the instructions contained in the Surveyor-General's circular No. 21 of 24th January 1879.

Along a line taken from the base to the top of the hill, contour lines at vertical intervals of ten feet were measured by means of a 10-foot rod and cross staff, to which a plumb was attached. The plumb gave to the cross staff the properties of a rough level, and enabled the field surveyor to plot on his plane-table the points marked *a, b, c, d, e* in diagram Z, between which the distances were determined by chain measurements, as shown in diagram Y. The object of the cross staff and rod was not so much to attain unnecessarily extreme accuracy, as to train the field surveyor by giving him his first few contours accurately plotted on his plain-table, and by this means to obtain a more correct idea of the number of contours required for the scale in use for the particular hill on the survey of which he was engaged. At first the field surveyor was directed to measure up lines from the base to the crown of the hill, as shown in diagram Z, ten chains apart, and to fill in his eye contours between each pair of measured lines. As practice engendered confidence, the distances from measured line to measured line, between which the eye contours were filled in, were increased to 20 and 40 chains.



Statistical and Geographical description of Syriam Township, District Hanthawaddy, British Burma. By CAPTAIN J. E. SANDEMAN, *Deputy Superintendent.*

THE Syriam Township is situated approximately between $\frac{16\ 50}{17\ 0}$ north latitude and $\frac{96\ 18}{96\ 3}$ east longitude, and covers an area of about 850 square miles, of which 793 square miles have been surveyed up to date. It is bounded on the north by the Pegu Township; on the south by the Gulf of Martaban; on the east by the same Gulf and the Sittoung river; and on the west by the Rangoon and Pegu rivers.

Geographical position and extent. Division into circles and kwins.

It is divided into the following Circles or "Tikes":—

Name of circles.	Number of kwins.	Total area. (Acres.)
Pagoo	11	19,729·50
Poo-gan-doung	41	71,845·84
A-goon	26	73,065·64
Than-hlyeng-myoma	21	25,078·48
Kyouk-tain-byin	25	34,524·20
Kyouk-tan	44	46,506·94
Yoon	18	32,907·76
Hmaw-woon	44	66,028·73
Met-ka-than	25	45,818·48
Kadoon-baw	9	37,154·01
Tada	31	54,603·75

A circle is a revenue division, and has its own "Tike thoogyee" or Officer to collect the revenue. As some of the circles are rather large, it is possible they may be still further divided ere long.

The circles are sub divided into "kwins." A "kwin" literally means a plain. It used to be the unit of assessment in the old days, all land in one kwin having been assessed at the same rate; but the Settlement now in progress divides a "kwin" into four classes of soils, the assessment on which varies from Rs. 3-8 to 12 annas an acre. A "kwin" is therefore only a convenient division of the circle, and corresponds to the Indian "mouzah" or village. The "kwin" is still further divided into fields, generally of a regular shape, where the contours of the land do not interfere. The field forms the "survey unit," and a group of these is held by each cultivator direct from the State.

The aspect of the Township is a vast alluvial plain, with hardly a tree in most parts, the only land-marks being the monasteries at the different villages, which are lofty buildings and are generally surrounded with clumps of tall bamboo and plantain. The creeks which intersect the plain are fringed with low mangrove jungle, which is fast disappearing as cultivation spreads. To the east of the Township along the sea coast, the jungle is still a few miles wide in parts, owing to the tract being inundated by the sea at high tides and being unculturable; but the silt yearly deposited is raising the land even here.

Aspect. The Kon-dan soil.

The one break in the general aspect is the low laterite ridge, in its highest part not more than 200 or 300 feet above the sea, which first appears at Thanhlyeng-myo, and, running parallel with the Rangoon river through the Than-hlyeng-myoma and Kyouk-tan circles, disappears at the village of Kyouk-tan, the last seen of it being the rocky bars in the Hmaw-woon creek, which appear high and dry at low water, and which cause the navigation of this important channel to be very precarious. It would help to develope trade, were a passage to be formed through these reefs by blasting the rocks. This "konedan," or high land, is evidently the last eastern spur of the Pegu-yoma. It is curious that the eastern slope is abrupt, whereas the western slopes are gradual, and disappear in the plain almost imperceptibly. Along the sea coast on the south of the Hmaw-woon circle, is a "dune" or sandy ridge, a few feet higher than the country inland, formed by deposits of silt. It is covered with jungle and is hardly perceptible.

The soil of the Township consists of clays chiefly, and of sands, varying from rich black clays to laterite sand and gravel.

Almost the sole product of the Township is rice, or what is locally termed by all Europeans "paddy" or unhusked rice. Captain Parrott, the Settlement Officer, in his report mentions the Burmese saying that there are 102 varieties of paddy; and as he collected 16 kinds in two villages, he thinks there may be some truth in the saying. He divides paddy into two descriptions—(1) ordinary, (2) glutinous paddy. The latter will not stand boiling, but has to be cooked by steam or in a bamboo, in which it is sold; it is very satisfying, and eaten before the cultivator goes to his labour in the morning. Of ordinary paddy, the Burman considers "meedone" the best, and "bawgoot" second best. For export purposes, "nga seing" is the only paddy grown in the township; this is a hardy kind, and preferred by the purchasers. Where cultivated, the entire plain is a paddy plain; but there are a few other products. Many edible plants are found in the fields, which the Burmese eat.

Products.

"Thekkeh," or thatching-grass, is obtained and sold chiefly by the "Shans."

The " danee " palm, which grows along the creeks, yields leaves used for roofing houses which are sold at from Rs. 2 to Rs. 5 per 100 leaves. The fruit and the juice of this palm are also sold.

The products of the " Kone-dan " vary from those of the plain. Much of the land is taken up as so-called " garden " land. Some of these gardens consist of nothing but jungle, with a few jack and mango-trees, but others are cultivated and yield pineapples, plantains, guavas, &c. They are all valuable, however, and are assessed at Rs. 3 an acre. The land on the lower slopes and foot of the Kone-dan produces a variety of crops, the chief being pawn, or, as locally called, " betel ; " the others, potatoes, roselle, pumpkins, onions, and chillies, &c. The pawn gardens here are not covered in as they are in Bengal, and the plant grows to a much greater height.

The Shans are great gardeners ; but I noted that Madrassees are taking up much land at the foot of the Kone-dan, and it was in one of their gardens that I noticed potatoes.

Modes of cultivation. Prices.

The mode of paddy cultivation is by sowing. The plough, which is like a huge rake in appearance, is first used after the early showers of the rains ; and after several ploughings have taken place, the seed, which is not carefully chosen being very often mixed, is thrown broad-cast over the field. No weeding is done, the seed being left to take care of itself. No manure is ever used ; but I have noticed that where manure has by chance fallen, a clump of paddy strong and high will grow, and sometimes a field will be dotted over with these clumps, which are readily seen. Only the ears of the paddy are reaped. The Burman does not stack the straw, which is burnt down afterwards, and forms the only manure the land gets. It is said the Burman reaps only the ears of the paddy, because he is afraid of snake-bites ! The threshing-floor is generally in some convenient field, the oxen that tread out the corn being left unmuzzled. The winnowing sieves are made of bamboo, and are hung from tripods of bamboos and swung backwards and forwards, the wind blowing away the chaff.

For the last few years, very high rates have ruled for paddy in the Rangoon market, and the average price this year is about 100 baskets or bushels for Rs. 90.

The prices of some of the other products are given by Captain Parrott. Bamboos, which are of three kinds, are sold from Rs. 3 per 100 to Re. 1 each ; pineapples are two pice each. A jack-fruit is sold from four annas to twelve annas. Mangoes from Re. 1 to Rs. 6 per 100.

Sometimes, when the rains are very heavy, some of the fields become flooded, and the yield is small ; but as a rule there is not much loss by floods in this township.

Tenure. Waste land grants.

The land is held direct from Government, and except in grants made under the Waste Land Rules of 1839-41 and 1863-65, there is no middleman. In the former case the cultivator enjoys fixity of tenure, in the latter he is merely a tenant-at-will of the grantee. Of these grants there are fortunately only 20 in the Syriam township, and it is possible that one or two of these may be resumed. The total area of these grants is 13,457 acres, or 21 square miles.

Modes and rates of assessment.

The new Settlement in progress classifies the land into four classes, on which the rates are as follow :—

	Average rates. Rs. A. P.
Class I	3 6 0
„ II	2 5 0
„ III	1 3 0
„ IV	0 12 0

The rate for the class varies slightly according to the " Settlement tract" it is in. Garden land is classed high, about Rs. 3. The yield of first-class paddy land is about 40 bushels per acre, and it diminishes to 10 bushels for the poorest land ; with careful cultivation, the yield might be doubled.

Increase in revenue owing to settlement and survey.

The new Settlement will raise the revenue considerably, owing to the rates being enhanced, and because the Survey has revealed that the area on which revenue was formerly paid was greatly in defect. In the six circles which have come under Settlement, the Survey has shewn the increase in cultivation to be 23·91 per cent., and the increase in revenue will be 36·22 per cent.

Other taxes.

Besides the assessment on the land, the cultivator pays a 10 per cent. cess by the new Act, and a capitation tax of Rs. 2-8 a year if a bachelor, and Rs. 5 if a married man. " Tari " and cocoanut palms are assessed at four annas each. Next year, all fruit-bearing trees are to be assessed at six annas a tree.

Labour and its remuneration.

The holdings in the township being large, averaging, as far as has yet been ascertained, about 43 acres, and the assessment light, the cultivators are well off, and seldom cultivate their own fields, but largely employ foreign labour, either Burmans from Upper Burma, or

gangs of coolies from Madras. Coolies for ploughing are paid about Rs. 30, and reapers about Rs. 24 a month.

The Burman generally does his own carting. The paddy is either stored in granaries in the village to be sold hereafter, or is sold to the owners of paddy boats in the nearest creeks.

Agricultural implements and stock.

The agricultural implements are the plough, the harrow, reaping hook, and winnowing sieves.

The cattle are very fine. The average price of a buffalo is Rs. 100, and of a bullock Rs. 70 or 80; they come from up-country; the mortality among them is great, owing to the Burmans taking no care of them.

There are no rules regarding grazing, and no tracts have hitherto been set apart for the purpose. The custom has been to send the cattle to graze under a cowherd, who receives payment in paddy. It is a strange sight in the rains to see a very small Burman boy astride on a large buffalo out in the "kwins," his sole clothing being a large bamboo hat to protect him from the rain; he has generally a large cheroot in his month, and thus he sits the live-long day, while the buffalo quietly grazes. A boy is mounted on every buffalo to prevent the animal from injuring the crops; and he seems quite happy to spend his day thus.

Grazing.
Grazing lands.

The new Settlement Department is setting aside grazing tracts in every "kwin," wherever land is available, in which no one will be able to take up land for cultivation.

The Rangoon and Pegu rivers, which border the township, are navigable for sea going vessels as far as Than-hlyeng, and the latter for very large craft as far as it borders on the township. The Hmaw-woon creek is 670 yards wide at its mouth, and is navigable for 30 miles for large paddy boats; during the rains paddy boats can go right through the creek to the sea, or to the Sittong river.

Principal rivers and creeks.
Yos.
Swamps.

The other large creeks are the Baw-choung, navigable to Thatay-kwin, Kama-ka-loke-choung, navigable as far as Kama-ka-loke, Pada-choung, Khanoung-choung, Mayaw-choung, Adoon-choung, Poogandoung-choung, and Kawet-choung, which are all navigable for distances depending on the state of the tides. During the rains, boats can go right through from one to the other.

All the creeks in the township are tidal, many of them overflowing their banks at very high tides. Besides those mentioned by name, the country is intersected with numbers of smaller creeks, many of which are silting up gradually. The banks of most of the large creeks are very high, and it is only at high water that any view of the country can be seen when sailing along.

When creeks have silted up and are no longer navigable, they are termed "Yo's," and appear as mere depressions without high banks, some of them being after a time cultivated.

In the Met-ka-than and A-goon circles there are considerable swamps.

The only road in the township is a very indifferent one along the crest of the "Kone dan," and runs from Syriam to Kyouk-tan. It has been partly metalled, but is in a very neglected state.

Roads.

The creeks therefore are the highways of commerce. It is true, in the dry weather, after the paddy is all reaped, fair-weather cart tracks are made from village to village; but these are only used to a limited extent, and parts of the township are not fully tapped for paddy till the rains set in and fill the smaller creeks.

There are no wells except at the villages at the foot of the "Kone-dan," because in the plain, the water, which is a few feet below the surface, is brackish and unfit to drink. Drinking-water is therefore stored in tanks. There is everywhere a scarcity in March and April, some of the villages in A-goon being deserted till the rains for want of drinking water.

Wells and water-supply.

The rainfall is about 100 inches, as far as I can ascertain; but there has never been a rain-gauge regularly kept until lately. Showers begin in April, and the regular monsoon bursts about the middle of May. There is hardly a shower from early in November till April. The temperature is very equable. In the dry weather it ranges from 60° to 94°, and in the rains from 75 to 90°, the mean in the dry weather being about 80 and in the rains about 82.° A cold weather is unknown; the nights are slightly chilly in January. Thick fogs prevail in the early mornings in the dry season.

The rainfall.
Climate.

There are various descriptions of boats to be seen on the creeks. There is the large Burman paddy boat with a carrying capacity of from 800 to 2,000 bushels of rice. There is the smaller Burman boat, in which are carried plantains, vegetables, and fruits of kinds for sale. There are Chittagonian or "kalah" boats, manned by the natives of Chittagong; these chiefly carry passengers. There are Burman canoes; and, lastly, the gaily-coloured Chinese sampans. Except the latter, of which the construction is different, the others, from the paddy boat to the tiny canoe, are flat-bottomed, the lower part being hollowed out of a single log, the lines of the boats being very fine. They all carry one square sail.

Boats.

The larger boats have beautifully carved chairs on the high stern, on which the steersman sits; at the bow there are grotesque figureheads of birds and animals, and the same also sometimes at the stern. Owing to their flat bottoms the boats can make no way against the tide; therefore it is that a fleet of every description of boat daily collects in the paddy season at the mouth of the Hmaw-woon and other creeks, and as the tide begins to make

all weigh anchor together. If there is no wind, the simultaneous creeking of the oars and chaunt of the boatman are heard; but the most picturesque sight is when there is a breeze, and they all set sail together. Some of the sails of the smaller boats are made of discarded silk garments, and the bright colors look pretty.

Towns and principal villages.

The capital of the township may be said to be Than-hlyeng-myo, commonly known as Syriam. It is merely a long straggling village with few good houses in it, and is a very dirty place. It is situated on the left bank of the Pegu river, at the foot of, and at the northern extremity of the Kone-dan, and is the site of an old Portuguese and Dutch settlement, the remains of an old fort and of a Christian monastery being still in existence. It has a population of about 2,000 souls.

The other principal villages are Kyouk-tan, on the Hmaw-woon creek; Kama-ka-loke, on the Kama-ka-loke creek; Khanoung, on the Khanoung creek; Pyin-magan, on the Pyin-magan creek; Tada, on the Tseng-ma-kan creek; Thone-gwa, on the Hmaw-woon creek; Thatay-kwin, on the Baw creek; Poogandoung, on the Poogandoung creek; Pagoo, on the Pegu river; Kayin, on the Kayin creek; Pada, on the Pada creek; Ok-kan, on the Ok-kan creek. In these villages many of the principal houses are built of teak. Pada is the site of an ancient town, and there are traces of ruins. Kyouk-tan is not a large place, but it derives its importance from the head-quarters of the Assistant Commissioner in charge of the Sub-division.

Kyouk-tan and Thone-gwa are laid out in squares, but most of the villages straggle along the creeks, one or two rows of houses on each bank. The houses are never built on the ground, but are raised on piles of wood or stout bamboos, the sleeping room being higher than the front veranda, which is the family sitting and dining room. Under the house the pigs and poultry live.

In villages built on creeks liable to inundation at high-water or in the rains, the principal roads are made of a single plank raised on cross sticks, or of bricks laid on edge or earthenware jars sunk in rows touching one another. Every village has its "Phoongyee Khyoung" or monastery; these are often picturesquely built like pagodas, or having three roofs superposed.

Classes of inhabitants.

The principal classes of the inhabitants are Talaings, Burmese, Shans, and Karens; the two former are in by far the greatest numbers, and they constitute respectively 43 and 41 per cent. of the total population.

The following table gives the numbers by circles, the total population of the township being 66,866, or about 79 per square mile:—

Circles.	Talaings.	Burmans.	Karens.	Shans.	Chinese.	Mahomedans.	Hindoos.	English.	Total
Than-hlyeng-myoma	2,573	1,958	.....	606	4	251	.....	.....	5,392
Kyouk-taing-byin	1,968	1,671	238	1,088	2	37	.....	.....	5,004
Toda	3,089	2,502	.....	356	15	.....	2	... ..	5,960
A-zoon	1,727	6,460	433	440	32	12	106	.....	9,220
Yoon	1,799	2,114	.....	2,718	25	.....	28	.....	6,684
Kyouk-tan	479	4,406	625	1,634	15	35	50	2	7,226
Hmaw-woon	4,075	3,411	.....	833	47	.....	225	.....	8,591
Poo-gun-doung	8,268	1,016	693	.....	26	.....	41	... ..	10,044
Met-ta-than	2,156	1,178	6	14	2	.....	12	.....	3,368
Pagoo	2,694	2,852	.....	99	16	3	9	.....	5,873
Kadoon-baw	.....	.....	.....	.....	.. ...	.....	.....	.....	...
Total ...	28,719	27,346	1,995	7,797	196	338	473	2	66,866

Manners and customs.

The population is almost entirely agricultural. Living so near Rangoon, the people are adopting many English customs. They use kerosine lamps and matches; English beds and mattresses; chairs with long arms, sprawling in which, the Burman, in very little clothing, his legs tatooed black from the waist to the knee, his body tatooed red, and with a large cheroot in his mouth, is a quaint sight. Near him may be seen his gaily-dressed wife, literally "his better-half," engaged in helping to husk the paddy for the day's consumption or in other domestic duties, but generally busy when not engaged at her toilet.

Here, as elsewhere in Burma, rice and dried fish (ngapee) and chillies, or a little vegetable, form the diet of the people.

The large villages have one or two shops in them, generally kept by Chinamen, in which are sold biscuits in tins, sardines, pickles, matches, twine, artificial flowers, umbrellas, and so forth. Soda water and lemonade are sold at stalls in the streets. There is also generally one liquor shop and an opium farm, kept also by Chinamen; at the former, beer brewed in Rangoon is sold, as well as infamous brandy.

All the people smoke, men and women, and even very small children. Their cheroots are six inches long, and are made of chopped wood and tobacco rolled up in a leaf; but they also smoke the cigar made in the ordinary manner. They chew betel to a great extent.

They eat out of lacquered trays and bowls, but also use China cups and plates, bed-room crockery sometimes being used at the meals of a large family. No such thing as "caste" is known in the country. On one occasion, when one of the Surveyors asked for a light, a Burman standing by hastened to the fire of an Oudh classie cooking

close by to get it, and when he saw the man indignantly throw away his food, he was surprised indeed.

There are many quaint customs amongst the people which we noticed, but most of these will be found well described in Forbes' "Burma." I may mention that at Kyouk-tan, when small-pox was prevalent, the entire population used to turn out in the evening at dusk with gongs and sticks; with the latter, they began to beat the thatch of their houses; the gongs sounded, guns were fired, crackers were let off, and the din was so great that at first, the cause not being known, it was most alarming. We ascertained that the "nats," or evil spirits, were being frightened away!

Funeral ceremonies.

Funeral ceremonies were pretty sights at Kyouk-tan. One would have hardly thought it was a time of mourning. The bier is of bamboos gaily decorated with flags. In front are young men dancing and singing, and playing on musical instruments. The villagers, chiefly women, in their bright colors, walk behind. A phoongyee heads the procession, a member of

"That noble order of the yellow robe,
"Which to this day standeth to help the world."

Villages bazars.

In every village all the inhabitants seem to have something to sell in a corner of their front verandahs, and in the evening a little bazar is formed in the main street. A few cheroots, plantains, ngapee, chillies, &c., form the stock in trade. Some stalls have also a table, laid out with cups and saucers and tea. The buyers are the boatmen and passengers going up and down the creek on which the village is situated; the young women and children of the house are the vendors, the men apparently being content to lie on their backs smoking all day, and only turning out in the evening to talk and flirt with the village belles.

In the whole township there is very little to be got to supply the wants of a European. There are no sheep or goats, there is no bread, nor vegetables worthy the name, no milk or butter, as Burmans do not use either; and the poultry the people will not sell, as they rear them to exchange for cloths with traders who come from Rangoon and go up all the small creeks in boats. The fowls are very fine, and are re-sold by these men in the Rangoon market at Re. 1 each.

Mahomedan colony.

At Than-hlyeng there is a colony of Mahomedans, who have a ziarat on the Kone-dan, and a mosque. They are descendants of the families who came from India with the Portuguese, but they cannot talk anything but Burmese; and, except in dress and religion, are quite Burmanised.

Education.

The education of the boys is chiefly carried on by the Phoongyee schools. Females are taught to some extent by nuns and old men.

Forests.

The forests consist of mangrove and willow on the creeks and along the sea coast, Pyeimma (*Lagerstroemia regina*), Thitsie, Danyeng,

Edible caterpillar.

Pyeng-kado (*Xylia-dolabri-formis*), jack-trees, mangoes, and bamboos of several varieties.

A caterpillar is found in the jungle which, when cooked on toast, is excellent, and tastes like marrow toast.

Remarkable buildings—
Kyoungs.
Pagodas.

Some of the "Phoongyee kyoungs," or monasteries, at Syriam, and those at some of the villages up the Hmaw-woon and other creeks, are worthy of note. They are generally large buildings on very stout piles, situated in a clump of fruit-trees or bamboos; the ground around is kept beautifully clean, and very often there are "zaiats," or rest-houses, around the kyoung for the weary traveller.

The principal pagoda is Kyaik-khouk, the one on the Kone-dan, four miles south of Thanhlyeng. There are pagodas worthy of mention also at Than-hlyeng itself and at Kyouk-tan. At the latter, on the reef of rocks about the centre of the Hmaw-woon creek, is a small pagoda, which is a conspicuous feature in the landscape. On the right bank of the creek is also a pagoda of great antiquity, although not of any beauty or size.

The golden pagoda of Kyaik-khouk is very handsome, being 130 feet in height and built of blocks of laterite. It is 1,200 feet in circumference. It is said to have been built before Christ, and that there are some relics of Gaudama buried under it. It is in charge of a Committee of Elders. The view from it is extensive, and it can be seen from every part of the township.

There are several small pagodas along the crest of the Kone-dan, and the ruins of many more, some of which must have been very large.

Burman officials.

For each circle (or *tike*) there is a revenue officer called the "tike thoogyee;" he is solely responsible for the revenue due to Government.

The "kyee-dan-gyee" is the head man of the village; he pays no capitation tax for which he performs various minor duties; he is also the village police officer. The "goung" is the circle police officer, who receives a salary of Rs. 10 a month.

Health.

The health of the people is good. In a few villages small-pox is prevalent generally from March till the rains break; but there is little fever or any other sickness, and the people may be said to be very healthy.

Litigation and crime.

There is a certain amount both of litigation and crime, but not excessive. The people are inveterate gamblers.

Religion.

The religion of the people here, as elsewhere in Burma, is Bhudhism. Monier Williams says:—"It cannot be said to be a religion at all, but a system of duty—morality and benevolence—without a real deity, prayer, or priest." There is no system of caste, and all men are considered equal. They believe in transmigration; they attach importance to charity, self-denial, and meditation. A daily occurrence in every village is the string of yellow-robed "phoongyees" or priests, who pass through the streets with bent head, begging their daily bread.

Arnold describes this scene thus—

"A yellow cloth over his shoulder cast
"Girt as the hermits are, and in his hand
"An earthen bowl, shaped melonwise, the which
"Meekly at each hut door he held a space
"Taking the granted dole with gentle thanks
"And all as gently passing where none gave."

Manufactures.

The manufactures of the township may be said to be almost *nil*. A little salt is manufactured at Theelwah, a village in the Myoma circle on the Rangoon river, by evaporation, and at a few other places. Some "thamaines" (women's costumes) are manufactured and sold by the Shans.

At Thone-gwa, on the Hmaw-woon creek, there are a number of sawpits. The timber comes through from the Sittong during the rains.

Weights and measures.

The ordinary Burmese weights are in use, one viss being equal to 3·65lbs. The English land measure is adopted, the acre being divided into 16 annas, and the anna into 12 pie.

Obstructions in creeks.

It has been mentioned that the creeks are the highways of commerce. The most important, and by far the largest of these, is the Hmaw-woon-choung. But unfortunately at Kyouk-tan, the reefs of laterite rocks, which have been already mentioned, greatly impede the navigation. The Government would confer a great benefit on the people if these rocks were blasted and a channel opened out. Kyouk-tan can now only be passed even by small passenger boats at high-water, and even then the navigation is difficult.

Ferries.
Bridges.

There are regular ferries at Syriam, Kyouk-tan, Thonegwa, Weh-gyee, Nyoung-lay-bin, Dayzat; the leases of the ferries for the year being sold by auction.

The creeks, if not very wide, are bridged at all the larger villages by wooden bridges for foot passengers. These, after the manner of the Burmese, are never repaired, and many of them are in a very rickety condition, being generally unsafe for ponies.

At the villages where there are no ferries or bridges, small canoes, often in a leaky condition, are kept by the village authorities for the convenience of travellers. I crossed in one at Pa-da-wah, which filled as we crossed, and we just landed in time, for in another moment it must have sunk.

Fisheries.

Many of the creeks and "yo's" used to be fisheries let out by Government, the lease being yearly sold by auction; but they have recently been all abolished, as when the creeks were banked up, the country became flooded, and a great deal of harm to cultivation occurred.

Postal arrangements.

There are no postal arrangements in the township, worthy of the name. There is a post-office at Kyouk-tan under the charge of the Assistant Commissioner; but as Burmans are employed as runners, the delivery of the daily post from Rangoon is very irregular.

Fairs and markets.

Cattle markets are held at Kyouk-tan and Nyaung-bin. Captain Parrott mentions that the largest transactions in paddy take place at Thatay-kwin, Tha-koot-kone (Ywathit), Nyaung-thoone-bin, and Joung-joung-ja, these being the termini of the land routes from the in-lying kwins.

Syriam Pagoda Feast.

The only large fair held annually in the township is the religious festival at the Kyaik-khouk pagoda. This fine golden pagoda, situated on the Kone-dan about four miles south of Syriam, has already been mentioned. The yearly festival takes place at the end of January, or early in February at full moon. It lasts for four or five days. I could get no estimate of the numbers assembled, but there must have been, I suppose, ten or fifteen thousand people at least. Many of the Rangoon traders send out representatives, and the inhabitants of the township make this the occasion of their yearly purchases of such articles as cannot be got in their villages. As our camp was in the vicinity, I was able to visit the fair, and found it one of the most strange and amusing sights I have ever seen. Amidst the trees and bamboo jungle at the base of the pagoda, and on three sides of it, was laid out a miniature town, with narrow but regular streets, lined with booths made of a frame work of light bamboos, and covered with coloured cloths. Behind the main streets were regular

encampments of the pilgrims and holiday-makers. The stalls were occupied by Chinese sellers of various sweets and jellies, Burman eating-shops, Chinese boot-makers, Madrassis and Hindustanis selling every kind of miscellaneous article; various peep-shows, in which photographs of London were being passed off as those of Mandalay. In the forenoon there were boxing matches. A ring being formed of the surging mass of human beings, two equally matched boxers came to the front, having their loins tightly girt; they first made their prostrations to the Assistant Commissioner and to the "nat," or evil spirit of the place; they then stood up, and, having made a few defiant antics, proceeded to business. Low music accompanied their movements, and as they warmed to their work and blows came thick and fast, the drums got louder, till finally the noise was deafening. It generally ended in the combatants being locked in each other's arms, and thus coming together to the ground, when they were separated by the umpires. Whenever blood was drawn, the match was at an end, and more prostrations having been made, the boxers were each presented with silk cloths. Then two more would stand up, and the fun lasted for some hours.

In the afternoon we visited the pagoda platform. Here was a most picturesque sight. The long rows of steps and the platform were crowded, with women chiefly, gaily and most tastefully dressed. The tightest of silk dresses, the colors of which are beautifully blended—a white linen jacket with a delicately colored silk handkerchief thrown over the shoulders, the shining black locks gathered up behind, with one or two bright artificial or real flowers stuck in at one side, the face done up with a white cosmetic or powder—is a description of the fair devotees. They would kneel down in rows and make their devotions in an earnest manner, then light a taper and place it as an offering, or else their good action would consist in sticking some gold-leaf on the pagoda, or they would offer a few flowers, oranges, and rice. Then they would pass on to listen to a singing minstrel, or blind fidler with a monkey, who had been all this time performing close by on the platform of the pagoda. Under the full moon, the picturesque crowd, with the golden pagoda towering above, was a sight not to be easily forgotten. The evening was devoted to visits to the Burmese plays or "pooeys." There were several going on, as well as some puppet pooeys, or marionettes. The posturing of the women was extraordinary, and the puppets move most naturally; but the thing that struck us most was the enjoyment of the Burmese crowd, and the hearty bursts of laughter at every joke.

History and antiquities.

Than-hlyeng is the site of an old Portuguese settlement. Here can still be traced the ramparts and bastions of a fort, which includes within it an area of over 20 acres; the walls were built of laterite and earth.

The *Gazetteer* says, according to Burmese tradition, the town was founded in 587 B.C. At the beginning of the 17th century, the king of Arracan took possession of Pegu, aided by the Portuguese, and to them he gave the town of Than-hlyeng, which they fortified; but they were driven out again a few years later.

In 1631, the Dutch were allowed to establish a factory at Than-hlyeng, which they retained till 1677. Then an English factory was established, but the date of this is unknown.

In 1740, the Peguans expelled the Burmese, but did not molest the Europeans.

In 1743, the Burmese re-took the town, but were driven out again immediately by the Talaings, who burnt the factory, this time to the ground.

Nothing now remains of these English and Dutch settlements, except the remains of

Ruins.

an old church (which must have been a grand building), the foundations of the fort, and walls of a few monastery buildings.

The *Gazetteer* says:—"The church was erected in 1749-50 by Father Nerini. In plan it consisted of a single nave ornamented with arches and columns both inside and out."

Hardly was the labour of constructing the church ended, when Father Nerini took in hand the building of a roomy house as a residence for the bishops and the missionaries. This old ruin is very substantially built with thick walls of small but well-burnt bricks; but trees are growing out of the walls and breaking them down, and it is a great pity that nothing has been done to preserve this ruin, which is such a grand monument of the earliest Christian enterprise in Burma.

Cultivation is extending very rapidly in the Township. Mr. King, Assistant Surveyor,

Cultivation extending.

mentions that when out surveying in Met-ka-than Circle, he met armed parties of Burmans exploring for land to make clearances; the men had come chiefly from the Pegu direction. A-goon is all cultivated except the belt of jungle bordering the sea, and in this Mr. King saw trees being felled, and the Burmans extending their cultivation.

The parts of Met-ka-than and A-goon, which are now a swamp, were evidently once

Traces of former cultivation.

inhabited by the Talaings before they were expelled by the Burmese, for there are the remains of tanks to this day.

Notes by CAPTAIN T. H. HOLDICH, R.E., *Officiating Deputy Superintendent of Survey, on the route to* KABUL *through the* LUGHMAN *Valley.*

THE course of the river Kabul, which, from its general directness, would form the natural highway between Jelalabad and Kabul, is unfortunately confined for some miles of its

length between precipitous walls of rock which offer little or no chance of successful road-making along its banks. There are four of these defiles (locally called *tangis*) between Kabul and Jelalabad, and hitherto their existence has been sufficient to divert the greater portion of the traffic of the country into the Gandamak-Jagdalak route, involving the passage of the Jagdalak pass which forms the connecting link between the Karkacha range, which is in itself a spur of the Safed Koh and the Seah Koh, which is really an extension of the Karkacha eastwards. Any route from Jelalabad to Kabul, running south of the Seah Koh, must either pass over the Jagdalak kotal (6,200 feet above sea level) or over some other pass of the Karkacha or Seah Koh, higher than that of Jagdalak. The disadvantages of this route, both politically and strategically, are matters of history; its disadvantage as a traffic route lies mainly in its gradients, which must either be excessively steep, or else the route must be lengthened until the rise of the Jagdalak kotal is spread over a sufficiently long line of ascent.

But it happens that only one of these defiles or *tangis* interferes with the adoption of the river route for a considerable distance (about 30 miles) beyond Jelalabad, and this gorge, which is known as the Deronta defile, is hardly two miles in length.

The Deronta gorge leads into a direct road to Kabul, which runs nearly due west along the northern base of the Seah Koh range, south of the river, for about 20 miles through the Lughman valley, and thence over an easy pass (called the Adrak Badrak) to Kata Sang and the Tezin valley. The whole of the Gandamak-Jagdalak route is thus turned, and with it all the difficulties involved in the ascent of the pass, the dangerous nature (strategically) of the pass itself, and its disadvantageous position as regards the neighbouring Ghilzai tribes. The Lughman route, too, is shorter and flatter, involving much less wear and tear on any transport system which may be worked along it.

About the end of January a working party of Madras Sappers and Miners, supplemented by cooly labour, was employed in making a practicable road over the Deronta hill, west of the river (which takes a southerly bend through the gorge), so as to avoid the double passage of the river across two awkward fords. The hills east of the river trend down to its banks in low spurs of soft sandstone rock, much mixed with water-worn boulders, which offer very little difficulty to the passage along its banks of laden baggage animals of all descriptions; so that it has been usual to cross the river to the left bank, and then re-cross in order to enter the Lughman valley. On the western bank the Seah Koh range comes to an abrupt conclusion, breaking up into rocky limestone spurs which terminate in precipitous cliffs right over the river bed. It is over these cliffs that the road was made. The crystalline limestone rock of which they are composed proved superficially soft and friable, and the three and a half days labour bestowed on the road resulted in a pass which was practicable for lightly laden baggage animals of all sorts, except perhaps that class of camels taken from the plains of India, which have been collected for transport in the hills of Afghanistan. This pass, as first laid out, rose to a height of about 650 feet above the plain; but an alternative road has been surveyed and is in course of construction, rising only 300 feet, and another even is contemplated, which will pass almost at the river level round the base of the cliffs, and be suitable for any sort of traffic.

From the top of the Deronta pass the Lughman valley, backed by the rugged hills and snowy peaks of Kafiristan, is spread out in a grand panorama to the north and west, and appears at the first view to be a well-irrigated, highly cultivated plain, full of flourishing villages, protected by the usual square-built bastioned mud forts. This is the nature of all the districts called Kuj, in which are situated the forts of Asmatulla Khan, and it is also the case with that part of Lughman, north of the Kabul river, which is watered by the Alishang below its junction with the Alingar; but by far the greater part of the Lughman district, from the immediate neighbourhood of the Alishang westwards to the Bad Pakht hills, consists of a dry, sandy plateau, covered with boulders and patches of coarse grass, deeply intersected by ravines and nullahs, and utterly unproductive. About a mile and a half from the northern foot of the Deronta pass is the village of Futteh Mahomed or Fatiabad, and a little beyond it is a small garden of cypresses and palms, laid out with much care and taste, near the fort of Bahram Khan. These are all some distance north of the foot of the Seah Koh, and in the midst of well-cultivated ground, apparently open and traversable, but in reality so deeply intersected by water-cuts for irrigation as to be almost impracticable for cavalry. The high road to Kabul passes between this cultivation and the hills, and for the first 10 or 11 miles runs nearly level, and is already a well-defined open road, owing to the amount of *Kuchi* traffic which has lately passed along it. For about 300 yards it skirts the banks of the Kabul river so closely as to require some additional width to make it practicable for wheeled traffic.

The first village on the road is Sakh Khan, almost exactly 10 miles from Asmatulla's fort, a small unimportant little hamlet built at the end of a sandstone spur, which extends from the Seah Koh down to the river bed. About a mile further, after crossing this spur by a low kotal about 100 feet above the river, is the village of Khair Khel, containing about 300 houses, with some cultivation reaching down the banks of the river. From this point cultivation only exists in small, unimportant little patches on either side the river, and the villages are insignificant. The road from Khair Khel passes over a low, stony plateau, only a few feet above the river level, much of the same nature as that existing between Jagdalak and Kata Sang, only without the deep, intersecting water-courses which render that road so full of steep gradients. Nine miles from Sakh Khan is the village of Kuch Mahomed Alí, the last four miles of the road being fairly free from stones and easily

traversable. Two other villages are passed *en route*, viz. Kaghar Kuch and Urmur. The former possesses about 100 houses and a small, square, mud fort, measuring about 40 yards each way, the road running through the middle of the village and under the fort walls. There are a couple of small villages on the left or opposite bank of the river, about opposite to Kaghar Kuch, inhabited by marauding bands of Utman Khels, one of the numerous sections of the Ghilzai tribe. The villages of Sakh Khan and Khair Khel are peopled by Nasars, another section of Ghilzais, who are said to be occupied entirely in agricultural pursuits and not to share the marauding proclivities of their neighbours. There are, however, several villages not far from the road, but quite out of sight, hidden among the low spurs at the foot of the Seah Koh range, inhabited by Ahdamzies, who are well-known robbers. These villages between them could probably muster 600 or 700 armed men if necessary. The left bank of the river at the eastern end of the valley, and the valleys of the Alingar and Alishang contain many important villages, of which the principal appear to be occupied by Tajiks; Charbagh and Mandrowar are Tajik villages. Alishang itself, too, is Tajik. Mingled with the Tajiks are various sections of Ghilzais, Dehgans, and Safis, both of which latter people are allied by language and race to the Kafirs of Kafiristan. The Safis occupy a considerable extent of country fringing Kafiristan. They spread from the north of the Lughman valley and the southern slopes of the Kafiristan hills across the Bad Pakht range over the Ushin and Tagao valleys, probably into the valley of the Panj Shir, north of that part of the Kabul river which flows through the Doaba.

The village of Kuch Mahomed Ali may be said to terminate the Lughman valley. Opposite to it rise the rugged peaks of the Bad Pakht, themselves an offshoot from the great Chardi mountains which are piled up between the Alingar and Alishang. The Bad Pakht form the western boundary of Lughman, and over them runs a well-known Kuchi route from Mandrowar to Nagulu opposite Sarobi in the Doaba. About a mile west of Kuch Mahomed Ali the river emerges from the gorge known as the Dabeli, along which no track whatever exists. At this point, where it is about 2,200 feet above sea level, it is necessary to leave the river and rise gradually over the Adrak Badrak (so named from two peaks overlooking it) to a height of about 4,000 feet over a rough, but very practicable, ascent to the villages of Chota and Barra Durgai. Chota Durgai is about four miles from Kuch Mahomed Ali; Barra Durgai being about two miles further on at the foot of a descent of about 500 feet from the highest point of the pass. From Durgai the route runs nearly level across the stony plateau which forms the north-western base of the Seah Koh and Karkacha, and which reaches down from the mountain masses northward in long slopes to the Kabul river, forming a curious geographical feature, common both to Northern and Southern Afghanistan. This rough, uneven, plateau, through which the Kabul river runs, after emerging from the Kabul plain through the extraordinary defile known as the Tangi Garhu, gathering the waters of the Panj Shir, the Tagao and Usbin, and passing in succession through the Gogomand and Doaba valleys to the Dabeli defile, extends westwards to the Deh-i-sabz range (overlooking the Kabul plain), and northwards to the base of the Nijrao and Kafiristan hills. The only cultivated parts of it are those bordering the rivers mentioned, which here and there (as in Tagao and Sarobi) open out into valleys which, if they are narrow, yet show extraordinary richness and fertility, being filled with thriving villages surrounded by orchards, meadows, and corn-fields.

The Adrak Badrak route finally joins that of the Jagdalak pass at the northern end of the Parri-darra, or Jagdalak defile, thus turning that defile completely. But before its junction with the main route, it rises over the Dabeli kotal to a height of about 5,000 feet above sea level, falling again to 4,000 feet, which about represents the level of the Parri-darra. This descent forms the steepest incline in the whole route, and has required some special attention to make it thoroughly practicable. So that the whole difficulty of the Lughman valley route to Kabul from Jelalabad may be said to be distributed between its two ends—the Deronta defile and the Dabeli pass. Between these two points the road, as it exists in its unmade condition, offers very unusual facilities to a marching force from its contiguity to a large river and its easy gradients. The total distance saved by the adoption of this route from Jelalabad to Kata Sang would be about 12 to 15 miles; but there would be a saving in the gradient represented by the rise and fall over successive kotals and ridges, which would be much under-estimated by a mere comparison of the highest point passed over on this route with the known height of the Jagdalak pass.

The Lughman valley offers many points of great interest to the historian or archæologist. It is on the summit of the great white peak of Kund, overlooking Lughman from the region of Kafiristan, that Noah's Ark is said to have rested after the floods, and the valley of Dara-i-Nur, which lies on the border land of Kafiristan territory, leading into that land of romance and conjecture, still bears his name.

The famous zearat of Mehtar Lam (Lamech) is in the Alishang valley, and annually numbers of pilgrims repair from Jelalabad on a pilgrimage to the shrine.

Within the limits of Lughman no topes (or stupas) are observable, although they exist in numbers in the district of Jelalabad, and one of the best preserved of them is at Deronta, near the entrance to the valley; but there are other evidences of a former occupation by a Buddhist population in the caves bordering the river, both at Deronta and opposite Kuch Mahomed Ali. The Lughmanis too have ever been the connecting link between Kafiristan and the southern world in the matter of trade. Kafir slave girls brought down from the mountains to the Dara-i-Nur were introduced by Lughmanis through the markets at Jelalabad and Kabul to the harems of the wealthy classes of those cities. Kafir beauty is

famous; but it is probable that, as a matter for export, its value has been lately considerably depreciated. A list of marches from Jelalabad to Kata Sang is appended:—

Jelalabad to Asmatulla's fort	11	miles.
Asmatulla's fort to Khair Khel	10	,,
Khair Khel to Kuch Mahomed Ali	9	,,
Kuch Mahomed Ali to Parri Darra	13	,,
Parri Darra to Kata Sang	4	,,
Total ...	47	miles.

Notes on the LOGAR *Valley by* CAPTAIN T. H. HOLDICH, R.E.

FROM the western extremity of the Safed Koh range, about the position of the Shutargardan pass, there reaches out in a south-westerly direction a long watershed composed principally of bare, rocky hills, called the Michelga and the Shari Koh, till it reaches a point about fifty miles east of Ghazni. From here it bends suddenly to the north-west, almost at right angles to its original course, and under a new name (the Uluk Koh) it passes a little to the north of Ghazni, and becomes finally merged into the rough and crumpled mountain masses which originate the four great rivers of Afghanistan—the Helmund, the Surkh Rud, the Panj Shir, and the Kabul—and bind together such mountain chains as the Koh-i-Baba, the Hindu Kush, and the Paghman. This is perhaps the centre of the great web of Afghanistan geography. Over this watershed lie the principal passes from Northern into Southern Afghanistan, leading from Kohistan and the plains of Kabul, or yet more remotely from Afghan-Turkistan to the great Ghazni-Kandahar road, or to other routes less known to trade traffic; or travel in the direction of the Waziri country and the valley of the Gomul. Northward from this watershed the drainage is all carried into the Kabul river by the Logar and its principal affluent—the Shiniz. The valley of Shiniz and of the Logar, starting from the Sher-i-Dana pass, over that same watershed, close to Ghazni, would give the natural and most level line of communication between Ghazni and Kabul, but for the fact that after its junction with the Shiniz, the Logar still continues its easterly course till it rounds the corner of what may be called an accidental range. This would lengthen the line of route considerably, so that the Ghazni-Kabul road, after following the Shiniz to its junction with the Logar river, runs straight away northwards by the most direct line, rising and falling over a series of low kotals formed by successive spurs from the mountains on its left to Maidan and to Argundeh, and so through the historical Chardeh valley into Kabul city. Meanwhile the Logar, after an eastward course for 20 miles or so, receives an occasional tribute from the water-courses and streamlets draining the northern slopes of the Michelga, and then turns sharply to the northward, winding through a series of open plains connected by narrow tangis or gorges, after the fashion of most Afghan rivers, till it finally runs out in the Kabul plain, where it carries after all but a very insignificant tribute of water to swell the volume of the Kabul river. The reason of its insignificance will be presently explained.

The Logar valley throughout consists of a series of broad open plains bounded by rugged hills, from the foot of which long, low, sandstone spurs stretch down with gentle gradients towards the river, presenting generally an appearance of arid waste, which limits the cultivated strip along the river banks to a few miles of width; so that its general appearance from commanding hills and peaks is that of a broad, green ribbon of cultivation, lying extended along an open, sandy plain, with a few outlying patches of green here and there. The exception to this general appearance is where the river makes its way from one plain to another through a gorge or tangi closed in by rocky hills on either side. There are three such tangis in the course of the Logar. The Tangi Wardak, shortly after its junction with the Shiniz, conducts it to the Hisarak plain. From the Hisarak it passes by the Tangi Wagjan into the Charasia plain, and thence again by the Tangi Navishta into the plain of Kabul. It is difficult to estimate the volume of the Logar because of the drain on it for purposes of irrigation. Narrow as the cultivated strip may appear, it is sufficient to support a great number of very large villages, and its high state of cultivation is very remarkable. The river, in many places during the dry month of May, is run to a narrow thread by the amount of water carried from it to the surrounding crops. Large areas are flooded for rice, and the irrigation system is so complete as to appear even complex in some parts of the valley. The villages are connected by narrow watered roads, no more ground space being taken up by the roads than is absolutely necessary for communications which are never subject to wheeled traffic of any sort. In order to move troops with facility about the valley, it is as well to avoid the cultivation as much as possible, and to make use of the flat sandy waste that borders it. And yet the pleasure of the green shady lanes, over-shadowed by the sweet-scented trees which border each canal or cutting, surrounded by a waving sea of luxuriant crops, is such that a few extra miles, and perchance many extra hours of such marching, is barely inducement enough towards forsaking these cool, sweet paths for the hot, fierce glare of the unsheltered hill sides. And without wheeled artillery, there is no real difficulty in moving by these village roads. It is almost impossible to exaggerate the occasional beauty of the Logar valley, viewed from the river banks. The white-walled, square-towered villages (each with its bastioned fort) are literally buried in the groves of dark-green mulberries and palm-trees. Poplar avenues are by no means an unusual feature in the scene, while the wide fields of clover (in which one may wander knee-deep) and of wheat

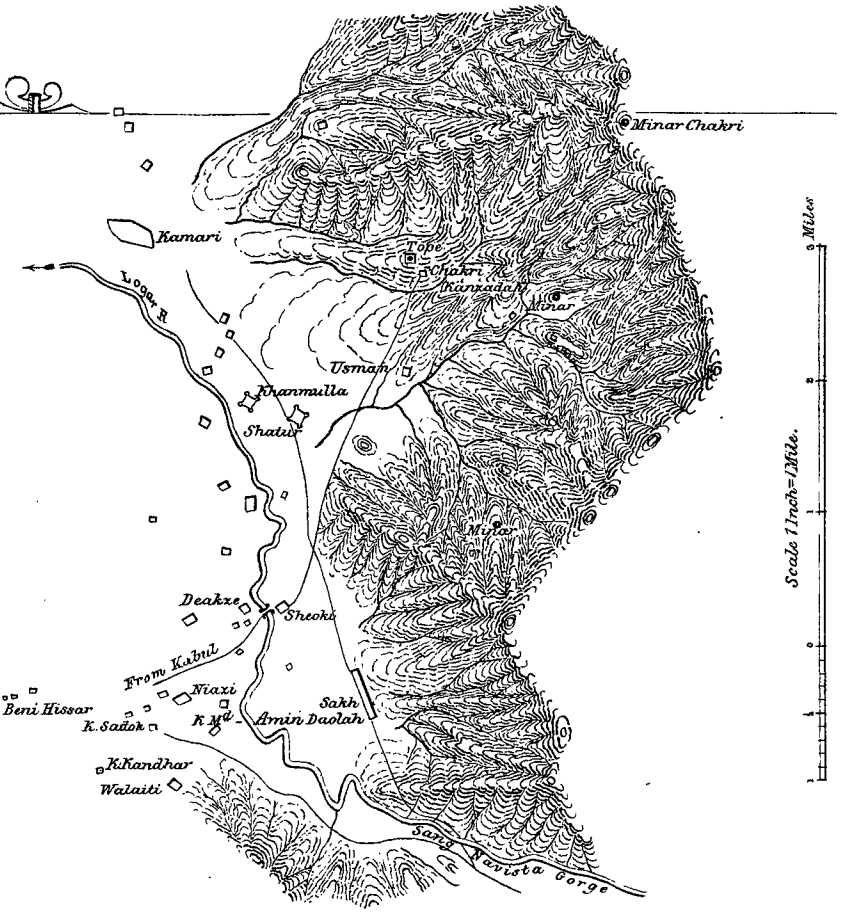
are fenced off either with low mud walls, or with hedges of the wild yellow rose carefully banked and tended. Occasionally broad stretches of soft smooth turf flank the river; but there is not, as a rule, much grass in the country. There is always the enchantment, too, which distance lends to the hot, rough-sided hills which are ever the back-ground of the picture: but the final charm of the distant snows is wanting in the Logar valley, and, in this particular, Kashmir scenery surpasses that of the Logar. The river gorges or *tangis* are always beautiful, without the grandeur and impressiveness of the Kabul *tangis*, but with a picturesqueness due to the wealth of vegetation which they enclose, which does not belong to the Kabul rifts. The Kabul gorges are so stupendous that it is impossible for the eye to measure them fairly, and some of them have never yet been explored by living soul; but the Logar passes, on the contrary, all admit of the passage of troops after some attention has been bestowed on the roads, and usually enclose a good strip of cultivation on either side the river.

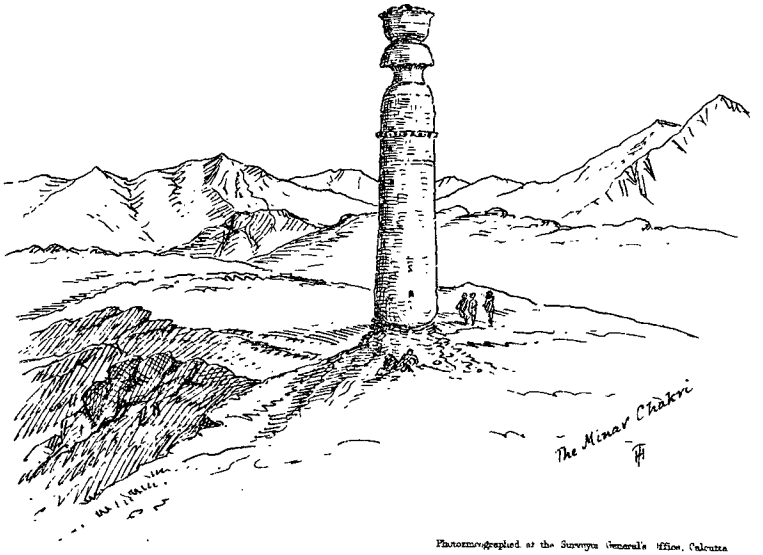
It is curious that south of Charasia the Logar valley should apparently be destitute of objects of antiquarian interest. There was at any rate, with one exception, nothing that formed a prominent feature in the landscape. At Hisarak there are ruins on a low hill overlooking the river, which were said to be Bhuddist. I cannot quite agree to this theory of their origin. They appeared to be far more like the remains of an old fort, of no great size, but in a fairly strong position, with a good command of the surrounding country; and as they form the solitary point of interest that marks the exception to the general rule, I should be inclined to suggest (in the absence of any authoritative description of them) that this is the fort that gives its name (Hisarak—small fort) to the adjoining district. From Charasia the Logar flows through a "*tangi*," called "Sangnavishta" ("or written stone") into the Kabul plain. The name refers to a stone which once existed in the gorge on which was an inscription. This stone is at present in Sherpur, and photographs have been taken of it, which will no doubt prove of great interest. Another stone with an inscription is said to be at Safed Sang, near Zahidabad, in the Logar country; but this I have never seen. I should think it possible that, wherever the word 'Sang' (or stone) is applied to denote a locality in North Afghanistan, there may have existed originally similar inscriptions on rocks in the immediate neighbourhood of that place. Near Kabul, where the Logar and the Kabul rivers are near to their junction, there are evidences of the former existence of a great deal of Buddhist architecture. The Takht-i-Shah or the summit of these hills south-west of the city, which were held so resolutely by the enemy in December until the assault of the 92nd Highlanders and 5th Goorkhas placed them in our possession, to be again transferred to Mahammed Jan on our retirement into Sherpur, is nothing but the remains of a Buddhist tope, partially excavated (and therefore affording most excellent bomb-proof cover) with caves below it on the western side of the hill. The Siah Sang hills are perforated with caves, some of which were unearthed by Lieutenant the Hon'ble Talbot, R.E., while constructing a road on the western face of the hill, but which he had not time to explore; while near the village of Chakri, about ten miles south of Kabul, are many specimens of Buddhist architecture in an unusually good state of preservation. A small map, on the scale of one inch to the mile, will best show the position of the minars and tope that have been observed there. No doubt there are many more evidences of Buddhist occupation, which have never yet come to light. The minar, which is perhaps in the best condition, and which has attracted most attention from its conspicuous position, is on the ridge overlooking the Kabul and the Kurd Kabul plains, and marks about the most convenient pass from one district to the other. It is 95 feet high, and about 62 feet in girth at the base; a picture of it appeared in the Illustrated News of January 24th, 1880, but its relative proportions have not been very well preserved; another sketch will be appended to this report. The early centuries of the Christian era, after the disappearance of the Greek and Scythian invaders, must mark about the epoch in the spread of Buddhism, when all these *minars* and *topes* were built. The masonry is peculiar (similar to that of the *topes* of the Jelalabad district), the small flat bricks or tiles which form the mass of the building being interspersed with rough natural boulders, which give it a curious spotted appearance.

The present inhabitants of the Logar valley are Ghilzais and Tajaks, the latter predominating. Previous to our occupation of Kabul, I believe the Logaris did not bear the character of being a particularly turbulent or troublesome people to deal with; but our experiences during the winter of 1879-80 prove that the Logari can equal the Kohistani in his fighting capacity, and fully justified Shere Ali's judgment in detecting the Logaris to form with the men of Wardak, the flower of his regular forces. At the same time the Logaris are most advanced cultivators. The Logar valley embraces quite as much cultivated soil as any district of similar physical and geographical conditions that I am acquainted with in India, and the cultivation is of a very much higher order. For the explanation of this apparently contradictory state of affairs, we must look to the division of races occupying the soil; and we probably find that the Ghilzai is, as usual, the fighting man, and the Tajak the ryot of the land.

Additions to Notes on the Logar Valley by CAPTAIN T. H. HOLDICH, R.E.

THE name of the small village near the tope, marked in the sketch map which accompanied the notes on the Logar valley, is Kanzada Kila, not Chakri. Chakri, which gives its name to the monuments generally, is in the Kurd Kabul valley (called Chakari in Mr. Claudius' map); there is no other village of the same name. The larger village, about a mile north north-west of Kamjada, is called Usman.





Photozincographed at the Surveyor General's Office, Calcutta

In the accompanying sketches the upper plate represents what appears to be the base of an unfinished *minar*, close to the *minar* which is marked on the map south-west of Usman (about a mile and a half). It is built of a mixture of brick masonry with stones interspersed exactly like the other *minars*, nor is there any appearance of the rounded top which is characterestic of topes. The ornament which runs round it is shown in figures 1 and 2, and slightly differ from that on the tope near Kanzada in the construction of the arches which are centered in the latter, but not in the former. All these ruins have been excavated, and I was told by an old man who remembered the excavations being made, that a silver casket, containing coins and relics, was taken out of the tope, but nothing out of the *minar*, except small earthenware saucers like those used for *charaghs*. The tope evidently is of a more recent construction than the *minars*. The dome is entirely brick, and there was originally a coating of plaster over it. It is about 40 feet in diameter.

Extract from a Report by MAJOR R. G. WOODTHORPE, R.E., *Season* 1879-80.

A FEW remarks on the triangulation may be of some value. It is founded on two Great Trigonometrical peaks known as Kadimakht Ghar, a point a few miles north of Thul, and No. 187, or "Dingsar" (its local name), the base being computed from the latitudes and longitudes given in the Synopsis of the Indus Valley Series. This base was chosen of necessity instead of taking one nearer Kohat, and working down from two absolutely fixed stations (instead of merely intersected peaks) as at first intended, as the state of the country between Kohat and Thul did not allow of the survey party leaving the main road very far on the south, and any attempt to visit the prominent peaks to the north was absolutely forbidden by the political officers at Kohat. A very good series of triangles was carried up to the Shutargardan in season 1878-79. A base in the Kuram valley was measured to commence work from, and when the triangulation was afterwards brought up from that, it was found that the difference in the values obtained by measurement with a subtense theodolite and by triangulation was only three feet, the total length being 4·03 miles. Of course it was impossible, under the circumstances of hasty marches and hostile people, to carry on the triangulation as carefully as it ought to be done; in many cases time did not allow of any mark, such as a cairn of stones, &c., being erected over the stations; and in other instances, where marks had been put up, the inhabitants destroyed them, and it was often very difficult, when the hills, as they so often are, are broad and flat-topped, to make out the exact spot over which the theodolite had been placed when observing back to these hills. The results are fairly satisfactory notwithstanding these drawbacks. The triangles are a little attenuated at the Shutargardan, any ascent of the Machalgu hills and the Surkhas range being forbidden. However, points on both these ranges had been well fixed, and by making use of them with supplemental angles, the triangulation has tided over that part and opens out again in the Logar Valley, and so on to Kabul. In November, having left all triangulation behind, a fresh base was measured in Sherpur cantonment, and from this base points on the Bemara ridge, Sher Darwaza, Khurd Kabul, and Karogh ranges were fixed, and as opportunity offered each of these points was visited, and from them many peaks on the Pagman, Hindu Kush, and Deh-i-Sabz ranges were fixed, which formed the basis of all the topography obtained around Kabul. Later on, this triangulation round Kabul was connected with that in the Kuram Valley, as I have explained, but the values thus obtained for intersected points do not differ materially from those previously worked out. The results of the triangulation* have not been finally worked out yet, but at present the values of a point common to the Kuram and Khyber triangulation differ by about 3′ in latitude and 9′ or 10′ in longitude. This difference may become less when the final results are worked out †

The height of Kabul will probably alter slightly with the final computations, as better vertical angles have been observed in the later Logar triangulation than was possible before, but there is no reason to suppose that the result will be very different. The heights are of the Kuram and Kabul triangulation points, obtained from Mirkwaili Sir and Tog as the initial points, though unfortunately reciprocal angles have not been observed at Mirkwaili. The value as at present assigned by the Kuram triangulation to Sikaram is 40 feet greater than that assigned to it by the Indus Valley series. This may be due partly to the fact that a house has been built on Mirkwaili Sir, immediately over the Great Trigonometrical station, the level of which it is now impossible to discover; and secondly, it is highly probable that the highest point of Sikaram was not observed to from the Indus Series, as a point a few feet lower looks the most prominent from all places east or south-east of Sikaram. It is only from the south that the real shape of the hill-top is discernible. The supposition is strengthened by the fact that the latitude and longitude of the Kuram Valley hill station of Sikaram differ from those of the Great Trigonometrical peak by about the distance that this lower point is from the hill station.

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* Since this was written, I have computed all the triangulations and intersected points, and worked out all the longitudes and latitudes of the secondary stations and of all the intersected points that are proved.

(Sd.) G. W. MARTIN, *Captain.*

† By my fresh computation I have only obtained a difference of 0·7 of a second in latitude, and 5·2 seconds in longitude from our old values.

(Sd.) G. W. MARTIN, *Captain.*

Report on the operations in Southern Afghanistan, by Lieutenant ST. G. C. GORE, R.E., *Assistant Superintendent, Survey of India, season* 1879-80.

I HAVE the honor to submit herewith my report on the work executed by me in Afghanistan during 1879-80 in continuation of last year's report.

On completion of my work in Pishin in October 1879, I received orders from Lieutenant-General Sir D. Stewart, K.C.B., to proceed to Kandahar to take charge of the work there.

Having met Captain Rogers, R.E., at Quetta, I took over from him such computations, &c., of the work about Kandahar as he had to give me.

I left Quetta on the 25th October, taking with me sub-surveyor Saidulla Khan, and took advantage of my passage across Pishin to fill in a few additional details on my map.

On arrival at Chaman, I received instructions from Kandahar to take an escort of men who were about to return and to proceed to Kandahar by the Barghana route, which lies north-east of the ordinary road. This I did, making a sketch of the route traversed and the surrounding country on the scale of 1 inch=4 miles, amalgamating my work with that previously done by Lieutenant Hobday on the Kandahar-Chaman road. This work is based on points trigonometrically fixed by Captain Heaviside, Captain Rogers, and Lieutenant Hobday.

I reached Kandahar on the 13th November. On arriving there I found that there was no immediate prospect of any field-work, and so devoted my time to putting my Pishin work in order. It was at last arranged that as some troops were going out of Kandahar towards south-west I might take advantage of their presence to extend the survey of the country round Kandahar on the scale of 1 inch=1 mile down towards the south west, thus mapping the fertile country lying along the banks of the Argandáb and Dori rivers, down as far as their junction, or further if possible. I started on the 12th December from Kandahar taking with me my two sub-surveyors, Atma Sing and Saidullah Khan, and an escort of 12 Goorkhas. My orders were to keep open communication with the troops who were to be despatched to the neighbourhood and to stay as near them as possible. A native official, the Shálgassi, was also sent with me by the Wali to aid me as far as possible.

I extended the triangulation about Kandahar as far as I could towards Girishk, so as to give the sub-surveyors fixed points to work on, and then started the detail survey. We continued the plane-tabling thus till the end of December, when I started with the intention of pushing down the Argandáb as far as I could, to try and extend our knowledge of the country in that direction. Unfortunately when I had gone three marches and reached Kila Shah Mir, just beyond Atakarez, I was peremptorily recalled by orders from head-quarters as rumours had got about that the country was in an uneasy state. The people however were very fairly civil to us, and my sub-surveyors had no difficulty in prosecuting their work, although their camps were at some distance from mine and almost unprotected. For this security I have to thank the Sartip (who has since deserted and joined Ayub Khan), who used all his influence to further the work. I was fortunately enabled to complete the survey of the country which was most essential, *i.e.* all the fertile and well-cultivated parts from which supplies were to be drawn to Kandahar. The area completed was about 160 square miles.

After waiting at Kandahar for about a fortnight, it was arranged to send out a reconnaissance up the Arghastan Valley for the double purpose of collecting supplies of bhoosa and grain and of enabling me to sketch the country. We started on the 22nd January 1880, Major Clifford, 2nd P. C., being in charge. We marched by Mandi Hissár, striking the Arghastan river during our third march. Our fourth march was to Amin Kila, where we were detained several days by rain and snow, the weather being bitterly cold. Hence we marched on up the Arghastan, passing its junction with the Khushk-i-Rud and camping amongst the Sundarzai villages.

Hearing that there was a good direct road from here to Kandahar, we rode out to explore it. The road led over a low watershed, the Tagak kotal, into the Tarnak valley, and was an excellent one though it had a bad reputation from being greatly infested by thieves. This road was afterwards used by the 1st Brigade of the Ghazni column on their march towards Kabul.

We continued our march up the Arghastan, passing the junction of the Lora and Arghastan rivers until we reached the village of Badozai, about eight miles from where the Arghastan issues from the hills. We were unfortunately unable to approach nearer Maruf than this point. Of the three rivers forming the Arghastan basin the Khushk-i-Rud is the smallest. Its total length is about fifty miles. A fair body of water, however, comes down it, but it is very brackish and nasty to drink. Of the remaining two the Arghastan has probably the larger basin, as a good deal of the drainage, which on old maps was shown as running into the Kadanai, is now known to flow into the Arghastan. The Lora river, we were told by several people, takes the overflow drainage of Lake Ab-i-Istada, and they said that when the lake overflowed the river-water came down very salt.

From this point on the Arghastan we turned southwards and marched down parallel to the main range of hills through the Kadanai plain, striking the Quetta-Kandahar road at Dabrai, whence we proceeded to Kandahar. The whole of the survey done during this trip has been based on trigonometrically fixed points.

I remained at Kandahar during the remainder of February and March preparing for the march to Ghazni. On the 27th March Major Leach, R.E., V.C., arrived at Kandahar from India. I at once made over to him all documents, &c., which were to remain at Kandahar.

Hearing that the first brigade of General Stewart's force were to move towards Ghazni *vid* the Khushk-i-Rud, I decided to move with them as their march would take me over a large extent of unknown ground. We left Kandahar on the 30th March, and marched for two days up the Tarnak Valley. Thence we struck across the watershed between the Tarnak and Arghastan rivers, crossing by the Tágak pass, which we had explored in our previous reconnaissance. We marched up the Khushk-i-Rud for four days, the country consisting of a tolerably level valley, much broken up in the neighbourhood of the river by hillocks and scarps of red earth and conglomerate. These attain a height of from 50 to 100 feet.

Thence we passed over an almost imperceptible watershed into the valley of the Tarnak, camping at Pamba, about 10 miles south-east of Kálat-i-Gilzai. We then marched along parallel to the Tarnak along the foot of the Surgarh hills, which form the watershed between the Tarnak and Lora rivers.

As far as Shahjui my survey depended on points trigonometrically fixed, but from that point onward I had to fall back on plane table triangulation and traversing as a basis for the detail sketching.

From the time we left Shahjui until we reached Ghazni the country was entirely deserted, and as the only guides who could be got did not belong to that part of the country, it was almost impossible to obtain any information whatever. In many places indeed I was quite unable to ascertain the village names. On the 19th April, the day of the battle of Ahmed Khel, I had with great difficulty obtained a hazara guide. After the fight commenced he several times tried to make off so as to get his share of the plunder, but was with difficulty restrained. At last a well caparisoned, riderless horse, passing near proved too much for him and he disappeared. I never heard any more of him.

After the battle was over we marched 7 miles in a thick dust-storm, when it was almost impossible even to tell in what direction we were going. This is a type of the many difficulties which a surveyor accompanying troops through an enemy's country has to cope with.

On the 21st we reached Ghazni, and as we stayed there a few days, I was enabled to make a sketch of the vicinity on a large scale, in which I was assisted by several Officers told off by the Assistant Quarter-Master-General.

On the 28th April we reached Saidabad and were in communication with General Ross's brigade from Kabul, and I was enabled to join on my work to that brought down from Kabul by Major Woodthorpe.

From here we turned into the Logar Valley, where we remained for about a fortnight.

We made a reconnaissance up the Altimor pass with the hope of getting a good view of the Zurmat Valley, but before I had been five minutes on the top of the pass the enemy appeared and I was recalled. A few shots were fired in among us as we retired, but no damage was done. I remained in the Logar Valley until all work possible there was completed. I then proceeded to Kabul and thence to Mussoorie, which I reached on the 19th June.

List of Heights along the road from Kandahar to Kabul traversed by the 1st Brigade.

They are all determined by barometrical observations.

		Height in feet.
Camp Marsinzai	...	3,697
Tagak Pass ...	...	4,718
Camp Kánat-i-Mir Alam,	Khushk-i-Rud Valley.	4,474
,, Sariche,		4,457
,, Mir Afzal,		4,666
,, Salam Kila,		4,952
,, Sheru,		5,577
,, Near Kuram,	Tarnak Valley	6,302
,, Khaka,		6,176
,, Opposite Shajui,		6,057
,, Jafir,		6,652
,, Martaza,		6,369
Camp Mukur,	Tarnac Valley	6,561
,, Karez-i-Oba,		6,986
,, Jamrad,	Ghazni Valley	6,974
,, Mashaki,		6,900
,, Ispandi,		7,252
,, Ghazni,		7,279
Sher-i-Dana Pass	...	8,373
Camp Shashgao,	Logar Drainage	8,184
,, Haftasia,		7,896
,, Haidar khel,		7,204
Zamburak Pass ...	...	7,872

Notes on the Valleys of Mastung, Mungchar and Kelát, by Mr. C. P. Torrens, *Assistant Surveyor, season* 1879-80.

The Kelát series emanates from the stations of Dhik and Landi, near Quetta, of the Beluchistan series, and is carried down south to the city and fort of Kelát. The stations of the series are on the high hills east and west of the valleys of Mastung and Mungchar, through which the high road from Quetta to Kelát passes. The nature of the hills is the same as those of the Bolán and about Quetta, with this difference that instead of a confused

mass, they run in parallel ranges from north to south and have wide fertile valleys between. Some of the ranges rise up in small steppes, notably the Avagul hills, towards the south-east of the valley. These steppes are generally well supplied with water from wells and are cultivated by the inhabitants. A remarkably fine steppe or plateau exists below the survey station on the Avagul range, its height is 8,000 feet above see level, and the steppe would make a good sanitarium for the troops at Quetta; it has four or five wells and a number of fields. The heights of the hills used as stations on the series, vary from 7,000 to 10,750 feet above sea level, the latter being the height of Koimarán (literally the mountain of serpents), a well known hill and the favourite resort of the shepherds of the country during summer.

The valley of Mastung, 28 miles in length from north to south, and having a mean breadth of 8 miles, narrow and very stony at the south, and widening to 16 miles at the north, is one of the most important in the northern portion of Beluchistan. It is watered by numerous hill streams, of which the chief is the Durisuna, which takes its rise in the southern hills and flows north almost the entire length of the valley. The Pashakuran Nalla is the second in importance; it rises in the Zairigat hills north-east of the valley, and flowing west, unites with the Durisuna, and then falls into the Sirinap river which flows north towards Shorawak. The valley is very fertile; cultivation commences along the banks of the Durisuna, where the river reaches the low lands about the centre of its course, and fields continue increasing in number as the volume of the water is augmented by additional streams from the hills, till the northern portion of the valley is reached, where the country may be termed an immense garden; fields abound and are thickly interspersed with orchards of apricot, mulberry, and other trees. The chief passes leading into the valley are as follows:—at the north, the Nishpa, from the Shál or Quetta valley, passable for wheeled artillery; at the north-east, the Mastung-i-lak from Darwáza (the Bolán), and the Dasht-i-be-daulat, passable for laden camels; at the east, the Avagul or Rambak, from the Ghor road, connecting the Dasht-i-be-daulat with the Robdar pass, passable for lightly laden camels and mules; at the south, the high road from Kelát, passable for wheeled artillery; at the west, the Chotak, from the Sirinap valley, passable for lightly laden camels; and at the north-west, an easy pass from the Kanak valley. The chief town is Mastung, from which the valley takes its name. It contains about 3,000 inhabitants, chiefly Brahuis, and boasts of a fort, admittance to which was refused, so I am not able to give a very minute description. The fort is square, and has mud walls about 25 feet high, loop-holed; at the corners are bastions, capable of mounting guns; it has one gate facing the town towards the east and two or three sallyports, and is garrisoned by a few of the Khan of Kelát's regulars, armed with the old Brown Bess. Tiri, a great mart for grain, is about six miles north of Mastung, and is the second town of importance in the valley. Besides Mastung and Tiri, there are many other villages and hamlets scattered about the northern portion of the valley.

South of the Mastung valley lies that of Mungchar; it is much smaller than that of Mastung, but very fertile. Its length from east to west is about 16 miles, and its breadth about 6 miles. It is watered by a branch of the Sirinap, which takes its rise in the Koimarán and Melabi hills to the east. Besides this stream there are a number of curious, underground canals termed Karez, described in previous reports by survey officers in Afghanistan. The valley is thickly inhabited and has a number of small hamlets, but no village of any magnitude, with the exception of perhaps the village called Hindu-ke-shahr, assigned to the Hindus, situated near the road to Kelát, which contains from 50 to 80 houses. From the valley there is a direct road to Darwázo (the Bolán) passing by the hill of Koimarán; it is however, seldom used, as water is scarce and villages few *en route*. Another road through the Shekh Háji pass to the east leads to the Robdar pass, and is much used during the migration to and from the Katchi plain. The road to Kelát by the Marján pass is very good and is passable for wheeled artillery.

The valley of Kelát is very small in comparison with Mastung and Mungchar, but is quite as fertile; the town and citadel of Kelát are situated towards its southern portion. The town is enclosed by a high wall once capable of having guns mounted, but now in a dilapidated condition; it has three gates. The streets are dark, narrow and crooked, and the town is kept in a filthy state; its reported number of inhabitants are 4,000; besides these the environs contain a very large number. The citadel is towards the south-western portion of the town and contains His Highness the Khán's residence. The approach to the palace is very strongly guarded; four or five gates and sentry posts, besides a long dark tunnel have to be passed before it is gained. The palace audiance hall or council chamber overlooks the town and surrounding country for some distance, and it is here that the Khán passes most of his time.

The country through which the series passes is inhabited by Brahuis. Two or more slaves are to be found in each family; they are generally brought from Sehistan and the western country, and are worth,—a woman Rs. 100, and a man about Rs. 200; they are generally well treated by their masters. Slaves of the African type are preferred to any other, as they are considered more faithful. A Hindu village, as already mentioned, was met in the Mungchar valley; it is inhabited by Banias (Karads) originally from Shikarpur in Sind. Some of them no doubt are well-to-do, but all openly profess to be poor; they dare not wear jewels for fear of being robbed. Avariciousness being the ruling passion of the Brahuis, they were rather glad than otherwise at a survey party being in their country, as they could make a little money. Their demeanour was that of indifference to what I did

so long as they got paid. No escort was thought necessary for me when working on this series, and so I had none ; happily no mishap of any kind occurred during the work.

From a surveyor's point of view, the country triangulated is all that could be wished for, but it must be done during the summer. Circumstances necessitated that the series should be done late in the season,—November and December,—and consequently the hardships and exposure endured by the party were very great. The minimum thermometer on occasions registered 5° below zero, *i.e.* 37° below freezing point, and when it is remembered that hills, in some instances, of over 11,000 feet had to be ascended, sometimes without guides and lived upon for two or three days with an insufficiency of clothing and food, and no tent, the hardships can better be imagined than described. The native establishment underwent the exposure cheerfully, and gave up many caste prejudices.

Report by MAJOR R. BEAVAN, B.S.C., *Assistant Superintendent, Survey of India, on Survey Operations in Southern Afghanistan and Beluchistan, season* 1879-80.

IN September 1879 I received instructions from Kandahar, through Major Campbell, R.E., to investigate the geography of the country between Sibi and Quetta. I was then at the Khojak Pass, and, taking advantage of the first convoy, I marched to Quetta, arriving there on the 23rd September.

Captain Beavan's movements.

I here found that a portion of the escort of the Governor-General's Agent, with Captain Showers, Political Officer, and Lieutenant-Colonel Bergman, in command, was about to start to explore the route to Sibi, *viâ* the Hanna or Hamra Pass. Making hasty arrangements, I left Quetta with them, early the following morning. Mr. Price of the Bombay party, who was at Quetta at that time, furnished me with the approximate positions of several prominent mountain peaks on which my subsequent work was based. The values given me were not very accurate, but I had to make the best of them, and succeeded eventually in getting a sketch of the whole country between Quetta, Thul-Chotiali and Sibi, which I have been told has proved of great value to the Engineers employed in laying out the new line of railway—rough though it is.

We marched *viâ* Astangi through the Tiri defile to Saugan, which we reached on the 6th October 1879. From Quetta to Astangi the road is good and the country open, but below Astangi the only route is along the bed of the river, flowing between lofty hills, which close in at several points, leaving only a narrow gorge for the passage of the water. In many places the troops had to work for hours before a practicable path could be made for the camels to pass, and at a short distance from the end of the Pass many days were expended in clearing a road.

Altogether it was found that the idea of making a railway, or even a cart-road, along this route, would have to be given up.

At Saugan we remained a fortnight, pending the arrival of Sir R. Sandeman, and the setling for our further progress with the Marri chiefs, who came to Saugan to meet us.

On October 19th, Captain Showers and Lieutenant Jennings, R.E., started from Saugan to explore a direct road to Sharigh and Dargi. I accompanied Sir R. Sandeman's party, and on the 21st we marched to Bahdra, on the 22nd to Mian Kach, and on the 23rd to Harnai, not without some threats of opposition, which however were not carried out.

The road from Saugan to Harnai is good throughout, but in one or two places along the Gandakin river it passes through narrow defiles, commanded on both sides by steep and rugged hills, where it would be exceedingly difficult to force a passage against a determined enemy. Again, a couple of miles on this side of Harnai, the road passes over a low kotal, affording a very strong position for defence. This kotal, we were told, was occupied by Pathans, but on approaching it we found this was not the case. The road *viâ* Mian Kach can be avoided by turning north at Spintangi through a rift in the limestone ridge, but at the time we went up, this was not practicable for camels. Captain Showers rejoined us at Harnai, having explored as far as the Chapa defile. From Harnai we marched to Sibi, arriving there on the 30th October, in order to meet His Excellency the Governor of Bombay, who proceeded thence with Sir R. Sandeman up the route we had opened out *viâ* Saugan to Quetta; meanwhile I remained at Sibi and Dadur, and on the 9th November I was joined by Messrs. J. T. U. Coxen and H. Corkery, Assistant Surveyors, who were placed under my orders.

Having made arrangements for these two assistants to take up the topography of the low country near Sibi, I returned with Sir R. Sandeman's escort to Harnai, and on to Khost, where we met the Governor of Bombay and the Agent to the Governor-General on the 23rd November 1879. During a day's halt at Harnai I visited Torgarh or Tongarh Hill, about six miles south, and erected a station on the summit, from whence a good view was obtained over the whole country towards Saugan and Nari. I observed some angles hurriedly, but had not much time to spare in order to reach camp again by nightfall. Returning from Khost the whole camp marched *viâ* Harnai to Thul-Chotiali; the road between these places is now fairly good, but at that time there was nothing but a mere track: it has since been much improved. The drawback is the scarcity of water, which at one halting place (Sambar) is quite salt and unfit for use.

At the request of His Excellency I prepared a sketch map of the country to illustrate his report, which has since been published.

On the 6th December Sir R. Sandeman started for India *vid* Vitakri, leaving his escort to garrison Thul. I was therefore obliged to remain at Thul till an opportunity should occur of returning to Sibi. I employed my time in preparing a tracing of my survey for the Assistant Quarter-Master-General at Kandahar, and on other office work. We also made expeditions with some of the troops towards Chotiali, and to Baghao and Smalen or Smaber, where we spent Christmas day.

On the 3rd January I finally left Thul with a detachment of the 19th Bombay Native Infantry, who were sent to repair the road between Thul and Spintangi. I arrived at Sibi on the 12th, in time to witness the arrival of the first railway train and the opening of this portion of the Kandahar railway. During the remainder of the field season—*i.e.*, till the end of March—I was employed at Sibi and Dadur, laying out triangulation and observing, superintending the detail work which was being executed by Messrs. Coxen and Corkery, and doing office work—computations, accounts, preparing annual report of previous year's work, &c. By permission of the Surveyor-General, and with the sanction of Sir R. Sandeman, I left Sibi on the 1st April in order to take the records which I had with me, of 18 months' work in Afghanistan, to the head office at Mussoorie, and complete them there. I was also anxious to procure any data that might be available for my future work, the Beluchistan and Kelát series of triangulation not having been calculated out up to that time.

On my return to Sibi on July 27th, I was anxious to proceed at once to Quetta, and to push on with the detail survey that was being executed by Messrs. Coxen and Corkery. I found, however, that the resources of the Transport Department were being taxed to the utmost by the despatch of troops to the front, and no carriage was procurable in the country on hire.

Shortly after this the news of the defeat at Maiwand arrived, and all survey parties were recalled from the field. I was thus detained at Sibi until the 4th September, when I succeeded in getting carriage and started for Quetta. I subsequently accompanied the force proceeding into the Marri Hills; this work, however, falls within the operations of the field season of 1880-81.

Mr. J. T. U. Coxen, Assistant Surveyor, joined this party on the 9th November 1879.

Mr. Coxen's work.

He was employed triangulating and plane-tabling during the winter near Sibi and Dadur and the Bolan Pass. During the month of April he was on leave, and in May he proceeded to Quetta with the office, and made arrangements for commencing plane-tabling work in the vicinity. Escorts and carriage had to be arranged for, and advantage taken of the movements of troops, as the temper of the Pathan tribes was very changeable and uncertain. During June and July Mr. Coxen was working in the hilly country east of Quetta, until he was recalled into Quetta on the 29th July 1880, on account of the disturbed state of the country.

Mr. Corkery also joined me on the 9th November 1879. He was employed plane-tabling near Dadur during the winter months.

Mr. Corkery's work.

In April he left Sibi with General Burrows, and marched up the Harnai route to Quetta. He was not able to do much on the way, but succeeded in sketching some bits of country that had not previously been explored. The tribes along this route were then in a very disturbed state. He was afterwards employed plane-tabling west of Quetta, until the survey work was stopped at the end of July.

Both Messrs. Coxen and Corkery have undergone a great amount of very hard work, and had difficulties and privations to encounter.

The work they have turned out has been carefully done, and they have succeeded in dealing with the Pathan and Beluchi inhabitants of the country without raising opposition or provoking complaints, which I consider highly creditable to them. They have been disappointed at not having had opportunities of sharing in any of the greater military operations towards the front, or of exploring countries hitherto unknown. Their labours, however, have not been unprofitable, although they may not have had equal opportunities of earning distinction as fell to the lot of surveyors employed in Northern Afghanistan.

Out-turn of work.

The amount of work done during the year may be summarised as follows:—

Tringulation.—Four new hill stations selected and cairns erected. Preliminary angles observed at five stations.

	Square miles.
Topography.—Reconnaisance more or less complete on the scale of 1 inch=4 miles	2,500
Survey in detail on the scale of 1 inch=2 miles	1,500
Total ...	4,000

Difficulties encountered.—The principal drawback to survey operations in this part of the country is want of carriage. I have tried, unsuccessfully, to hire camels by the month from the Dera Ghazi Khan district. The owners, however, refuse to come here on any terms.

Carriage.

The local Brahin carriage is entirely monopolized for the service of the troops, and camel-owners realize such enormous profits by carrying Government stores up the Pass at so much a maund, that they refuse to take service by the month. We have thus been entirely dependent on the Transport Department, and generally find difficulty in getting camels or carts at the times and places that we require them. This of course created great delay.

Atmosphere.

The next difficulty arises from the uncertainty of the climate, and especially from the dust and haze which loads the atmosphere at certain seasons, and prevents survey work being carried on at all. Last year thick haze filled the air in the middle of November. In December it was clearer, and in January, February, and March 1880 there were a succession of furious dust-storms which for days together hid every hill from view.

Water.

The scarcity of water is also a cause of delay. Many parts, both in the hill and plain country are quite destitute of water, and in other places where water exists it is salt and unfit for drinking purposes. Hence special arrangements have to be made for bringing water to the camp from a distance, and half the day is frequently lost in going to and returning from work when the camp cannot be pitched near at hand.

Health.

A natural result of bad water, and an unequable climate, presenting great extremes of heat and cold, and, of coarse, food, is a considerable amount of sickness both among Europeans and Natives of India. The country is not adapted by nature for hard work, and it cannot be carried through without distress and much strain on the constitution.

Guards.

In an unsettled and hostile country it is of course necessary to make due arrangements for the protection of the survey parties. Advantage has to be taken of the movements of troops, and the surveyor is constantly kept idle on this account. He is moreover often unable to visit some prominent hill, or to explore a confined tract of country which is essential in order to fill up a gap in the map.

The Military authorities will usually render every assistance in their power, but are not always in a position to send guards where the survey requirements would demand.

For instance, on applying for a guard to accompany Mr. Coxen into the hills between Sibi and Bahdra, I was told that the guard could be given, but that they could not be provided with carriage for themselves and the necessary supplies. For these reasons it is advisable to trust as much as possible to protection from the inhabitants of the country, but great watchfulness is requisite against thieving. Several cases have occurred of camels, &c., being stolen at night, and not much redress is to be had from the Civil authorities on these occasions.

It will be seen, therefore, that survey work in Beluchistan is liable to serious difficulties and hindrances, and it is not to be expected that the out-turn will be equal to that which might be obtainable under more favourable conditions.

By Topographical Branch order No. 48, dated 12th July 1880, the party under my orders was organised as a regular party for the survey of Southern Afghanistan, Beluchistan, and the adjacent country, under the designation of the "Beluchustan Topographical Party." During the present and following seasons I trust we shall be able to complete a considerable area of country in a systematic manner, on the scale of 1 inch=2 miles. The existing maps of Beluchistan are very valuable, but not having been based on geographical data, the positions of the various towns, &c., are naturally incorrect in latitude and longitude. There are also many blanks to be filled up between the various routes that have been laid down by travellers. These deficiencies I hope we shall be able to remedy in due course.

Extract from a Report by CAPTAIN J. E. SANDEMAN, *Deputy Superintendent, Survey of India, on the* IRRAWADDY RIVER *Exploration, season* 1879-80.

MANY conjectures have been formed from time to time as to the source of this great river, D'Anvilles' theory and that of others being that it is identical with the Tibetan river, the Sanpo. This theory has been recently warmly advocated by Mr. R. Gordon, C.E. On the other hand, Captain Harman of the Survey Department has, by personal observation and by the aid of explorers, all but proved that the Sanpo falls into the Brahmaputra.

Former attempts to explore this river have been limited to the following:—

Wilcox in 1825 visited the source of the western branch. Mr. Strettell, of the Forest Department, in 1874 went a few hours' journey above Maing-na, although he believed himself to be in latitude 26°. How he saw the junction of the two branches of the river is strange, for it does not take place for nearly 30 miles beyond Maing-na, the spot from which the people told the explorer he turned back. At page 170 of his narrative he says:—"*4th February* 1874.—At 8 A.M. we left Maing-na ..... The river increases in impetuosity ..... We found ourselves passing up a noble gorge ..... The hills echoed forth the wild cries of my boatmen, cheering one another on as they endeavoured to stem the current .... Our progress was slow and the pace continued to decrease, until the crew found it was hopeless depending any longer on their poles .... They jumped overboard with their towing ropes and renewed the struggle, and straining every nerve, it was as much as they could do to creep along;" and then he describes how in a couple of hours

more their troubles were at an end, for he says: "Here the river divides into two great arms, that to the east being considerably the larger." On the 5th Mr. Strettell describes his return in fifteen minutes! Mr. Strettell's description of the rivers does not agree with that of the explorer, and I can hardly believe he could have got from Maing-na to the confluence of the two streams against such a current as he describes, in one day, and return in fifteen minutes! I think he must have taken a hasty glance from some distance and come to the conclusion he did: or else more probably he was deceived by the river being divided into two by an island. This actually occurs at Shanta-yoke-ywa above Maing-na, which I cannot but think is the spot reached by Mr. Strettell.

Dr. Anderson in his report on the expedition to Western Yunan, devotes a chapter to discussing the probable sources of the Irrawaddy. He is no advocate of the theory that the Sanpo is the Irrawaddy. He himself visited the first defile above Bhamo, and he gives the opinions of Hannay, Bayfield, and Griffith, who had been as far as latitude 25°.

Early in 1879 the Surveyor-General asked me if I would train a man to explore the Irrawaddy. I need hardly say I was only too glad to undertake the interesting task. Through the exertions of Mr. Burgess, the Secretary to the local Government, a man named A—a was obtained, who had volunteered, and with the sanction of the Chief Commissioner his training was proceeded with.

I soon saw that he was an intelligent man. He knew the use of the compass already. I trained him to pace and observe double altitudes of stars with the sextant. The latitude of Rangoon being too low, the sun could not be observed on the meridian, but he was taught to observe it off the meridian. I instructed him, as best I could, how in higher latitudes he would be able to get it at noon. On the 17th October 1879 he started with one A—e M—e, an elderly man, and M—o, a nephew of his own, as companions. The former had been trading in timber up and beyond Bhamo for years, and, although an elderly man, was in many ways fitted to make a good assistant to the explorer. The party took with them about Rs. 300, in gold principally, and the following instrumental equipment,—a 6-inch sextant and a supply of quicksilver, a small prismatic compass and pocket compass, two boiling point thermometers, a common thermometer, and a bull's-eye lantern. As A—a speaks Hindustani imperfectly, Messrs. Burgess and Pilcher, the Chief Commissioner's Secretaries, very kindly, and with great patience, explained to him all my instructions. A note was made of the index error of the sextant and variation of the needle, and of the reading of the thermometer when water boiled at Rangoon.

After an absence of less than six months, the explorers have returned, and although they have not been able to visit the exact source of the river, they have not been very far from it, and have done a vast deal to silence conjecture for the future.

The following is taken from A—a's journal:—

October 17th, 1879.—The party left Rangoon.

November 2nd.—The travellers reached Bhamo. There they remained till the 7th November. During their stay they looked about for a way of getting up the river, and at last found some Shan Kadoos starting for Haw-ka with salt, who agreed to take them for Rs. 5 each.

November 7th.—A start was made, and Maing-ka was reached by the evening.

November 8th.—The boat reached Tha-pan-bin. From hereabouts the river begins to narrow, and the rocky gorge continues to below Myintha. The current is tremendous, and the water forms into whirlpools between the large rocks that stand up as islands in the narrow channel. The explorer heard that in the rains no boat can row up, but that they had to be towed up with strong ropes from the banks; that some are yearly lost and people drowned. He says that the gorge is 200 yards broad at its narrowest. The people speak of it as "Kyouk-twin" or rocky gorge.

The inhabitants on both banks are chiefly Poons, living in about a dozen villages from Tha-pan-bin to Pagan.

November 11th.—On this date Pagan was reached, and on the 12th the island of Hnote-cho, a large village on an island inhabited by Shan Kadoos. The country on the banks along here is described as being a fine plain, parts of which were once cultivated. At this village limes are very plentiful. The people carry on *kaing* cultivation on the banks of the river and have gardens. The average breadth of the river about here is over a mile.

November 13th.—Poot-tay stream, south of Shway In, was reached. Here was obtained the first opportunity the explorer had of taking observations for determining the latitude.

November 15th.—Ayeing-dama was reached. From Poot-tay stream bearings of every turn of the river had been taken. The distances were also noted by time. The mouth of the Mo-goung river was passed. The explorer heard that up its course it widens out, that it is a large river, and that it takes its rise in a lake. From Ayeing-dama upward on every sand bank that is formed, the people wash for gold with great success. The river here is described as 2,000 paces wide: the eastern bank as 18 feet above the water.

Ayeing-dama is an old and once populous city, and is called after a King who lived here. There are the remains of a fort. The place was of importance till the reign of the Burmese King Alompra.

A large trade used to be carried on with China, and large tracts of paddy-land lie fallow. At present there are 20 houses of Shan-Kadoos and five of Kachins: the former pay revenue to Burma; the latter do not do so here or anywhere.

November 16th.—Haw-ka was reached. Here fresh arrangements had to be made for the party proceeding on. During their four days' stay they slept in the boat they had come

in. The travellers here remark that the teak forests ever since they left Tha-pan-bin have been very fine, and they saw other useful timber also. The inhabitants since leaving the island of Hnote-cho have been chiefly Kadoos.

November 20th.—The explorers were able to continue their journey through the good offices of their former boatman, who got a friend of his own to take them on in his boat to Ka-cho. They passed the Shan-Kadoo villages of Koung-boo and Ta-law. They heard that lately some Kan loung Kachins had made a raid on this village, killed the sawbwa, and taken possession of the village.

The people of Ta-law and Koung-boo wash for gold. Above Ta-law were met two tributaries of the river,—Nam-malee and Nam-tabet streams. Up these, Kadoos, and also Chinese-Shans, live. They are subjects of the Kan-loung King. The former pay taxes also to Burma. They grow opium. The Kachins about here obtain lead ore from the hills, and they were seen "to burn the rocks in a kiln" by the explorer. They take the lead to Bamo. There is a road to China from Nam-tabet, by which merchants bring cloth and iron cooking-pots. Above Nam-tabet there is a plain occupied by Kantees (Shans). They are emigrants from near the western source of the river. Further on was passed the village of Maing-maw, a Kadoo village. It is said to have been an important city; old paddy clearings still remain; also the ruins of a fort. At the present time there are 20 houses of Kadoos and five of Kachins. Pa-law on the right bank has 20 houses of Chinese-Shans. Pinpa and Sanka are Kachin villages.

November 23rd.—Ka-cho was at last reached. This is a large village of about 80 houses of Shan-Kadoos. It was built in olden days by a Shan governor called "Hawpyin." It was a very important city. It now pays tribute to Burma in the shape of a yearly present. It pays nothing to the Kachins. From Ka-cho also there was formerly a good deal of trade with China, but the depredations of the Kachins have closed the road.

There is a large village called "Zee-gyoon" on an island in the river opposite to Ka-cho. It has about 50 houses. The travellers were destined to make a long stay at Ka-cho. In the boat they had last travelled by they had heard that a saya (doctor) was the head man and much respected, and they had made up their minds to arrive as guests at his house. He received them hospitably, and as their stay continued the friendship warmed, and they received a lot of information from him about the people and country further on.

He told them that when the Panthays were at war with the Chinese that the latter came to Ka-cho and had there enlisted many men by offering Rs. 50 or Rs. 100, and that he had gone with about 80 or 100 men and had fought on the side of the Chinese; that after the war was over he remained in that country many months and had been up to the Noungsa lake, which was so wide that one could not see across it. He described that there were lots of people there, Shan-Chinese and Kachins too; that a river flowed out of the lake to the westwards, which could be no other than the eastern branch of the Irrawaddy. He said he was sure of this on account of the direction the water took.

On account of all they heard about the Kachins, the travellers during their stay at Ka-cho became convinced that it was useless their trying to proceed without a guide and interpreter, who at least could tell the Kachins what their object was in coming amongst them.

One day the Kachin sawbwa of a neighbouring village (Paroo) came to the house. They made freinds with this man and accompanied him to his village on the 18th December in the hope that he might consent to be their guide; but they had no success at Paroo, and returned on the 23rd to Ka-cho.

The explorers took observations for latitude at Ka-cho. Owing to the constant dread of the Kachins in which the villagers live, the houses are all shut up at 8 o'clock, sentries being posted, every man taking his turn. Tigers also enter the village and carry off cattle and pigs. There was a little courtyard behind the house where the explorer slept. He was there able to take some very good observations. He also boiled the thermometer here on two days, and in the day-time he went to the jungle twice, as he says, "with a *da* and his sextent" to observe the sun at noon; but these observations were not successful owing to his want of practice with the sun. The explorers one day applied to the Saya if he would not go with them, and when a reward was offered, terms were come to. He would not go however without a Kachin companion, and sent for one Makan-too, sawbwa of Pinpa village bellow Ka-cho. This man agreed to go as far as Sinpoung-poon, where the sawbwa, Laboo-shoung, lives. From the map it will be seen that this hill is a little further than the point from which the travellers had to turn back.

January 15th.—A start onwards was made. Mee-thoo-ma-hee was left behind with directions to return to Rangoon if the travellers did not come back in a month.

The party consisted of the explorer and his elderly companion, the saya, the Shan, Nga Kan-too, the Kachin, and a little Kachin boy whom the latter took with him.

January 16th.—Maing-na was reached. Waing-maw, Ywadaw, and other Shan villages were passed, each containing from 20 to 40 houses. Maing-na has 30 houses. Paddy clearing of former days lie fallow. The land is very fertile.* Many of the people of these villages and of Ka-cho live by acting as interpreters and brokers between the merchants from Burma and the Kachins. Above Maing-na there is no tribute paid to Burma, that being the frontier town. Shans also ceased, and hereafter our travellers found themselves entirely among Kachins, what are called the Kansa-Kachins.

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* The river here is over a mile wide, full of sand banks and small channels. The bank is steep, in two steps, the lower twelve feet in height, the upper eight or nine feet.

January 17*th*.—On this date their camp was in the jungle near Kway-too choung.

January 18*th*.—Yesterday the travellers noticed the river considerably swollen, and on enquiry were told that it was caused by the first melting of the snows. They heard also that the western branch of the Irrawaddy was called Malee-ka and the eastern branch Meh-ka. In the evening they reached Pouk-san-poon. They describe the hills as covered with the *Ficus elastica* from Maing-na as far as they went. From Ka-cho the distance had been paced steadily and the bearings recorded. The stars could not be observed; it was very cloudy and a good deal of rain fell. From here they had a view of the junction of the two branches of the Irrawaddy and saw some miles up the western branch. They thought it about 500 paces wide. They lived in the sawbwa's house.

January 23*rd*.—They went along measuring as before and recording, and reached Moo-koung-poon, where they put up with the sawbwa.

January 24*th*.—To-day they crossed the eastern branch of the river. They saw it was smaller than the western branch, and that there was no flood whatever as they had expected, for it will be remembered as they passed Maing-na they had noticed the river swollen. The river was some 300 or 350 paces wide, but at this season had in places a narrow channel of running water of 100 paces, and in other places deep and stagnant pools; as they saw up the river reach it was coming down in rapids over and round large rocks.

They had to cross in a ferry-boat, and they questioned the ferry-man why the river was not flooded. He said it was not so till April. In the evening they reached Pone-ka.

January 26*th*.—Reached Mara-poon hill. Went to the sawbwa's house.

January 27*th*.—To-day they crossed the boundary between the Kansa and the Kan-loung Kachins: these latter seem to be under what the explorer calls a "Badshah" who lives at Nga-kone-lapoon. They reached Mo-goung-poon Maing-koung. It will be seen hereafter that this was destined to be the termination of the route, and unfortunately no opportunity occurred of observing the stars. However, twice the sun was observed on the meridian on 31st January and 1st February, and although the difference is 6′ (instead of the mean), the last observation has been adopted, which the observer declares to be the best, and which tallies with the position of the place as obtained by the route so nearly that I have left it as plotted.

February 2*nd*.—The party moved to Tone-poon-poon, Pouk-lee-shoung, Akyee-wa's house. They began to make friends and to ask the road. They slept there one night.

February 3*rd*.—Returned to Mo-goung-poon.

The explorers were told of the custom of the Kan-loung Kachins, that if a Shan or Burman wanted to come to their villages, he must make friends with the sawbwa and come as an invited guest, and that no one was allowed to come and go as they were doing.

February 15*th*.—They were allowed to depart. I have asked the explorers why they did not try the Tazoopoon route by which the saya had once gone eastward. Their reply is that the whole country had heard of the black men, who were popularly supposed to be *Nats*, being in the country, and that they could not have gone a mile without being seized. As it was, on their return journey they avoided the villages as much as possible, and when they saw one, turned off into the jungle and took a roundabout road.

February 17*th*.—They put up at Pone-ka.

February 18*th*.—Crossed the river once more and saw that it had receded about three feet from a stone on which they sat on their former visit. They arrived at Pouk-san.

February 20*th*.—As they came in sight of the main stream they noticed that it was more flooded than ever; it had risen considerably since they had last seen it. This is a strange coincidence, that one branch should be falling when the main stream was rising, and points I think clearly to the nature of the two sources.

This observation of the explorer is quite an independent one, and was mentioned casually by him. He had no hint that he should watch the rise or fall of the river.

February 21*st*.—Ka-cho was reached.

March 6*th*.—They reached Bamo.

March 7*th*.—They found a Poongyee's boat proceeding down, by which they were allowed to travel.

March 24*th*.—The party arrived at Mandalay, and went straight on board the steamer, reaching Rangoon on the 2nd April.

The following are the explorer's notes on the people among whom he travelled:—

After leaving Bamo, the people first met with are Poons, whose dwellings are on the banks of the river. These people cultivate very little rice, and live chiefly on the produce of hill cultivation or *toungya*. They grow yams, potatoes, oil-seeds and cotton. Fish forms their principal food. They talk a dialect of their own. The women are dressed like Shans, the men like Burmans.

The Burmese extort from them as much as they can, there being no fixed rate of revenue.

The Kachins who inhabit the hills overlooking them also extort pigs, cattle, fowls, &c., from them, especially when there is a funeral or marriage and sacrifices have to be made. One Kachin sawbwa rules two or three villages; that is, he considers these as his legitimate prey, and no one but himself is allowed to extort from them. Whenever a Kachin dies, the Poons have to attend the funeral, each taking with him a spade, a *da*, a basket of rice and four annas in pice. The Poons are Buddhists. They build pagodas and reverence poongyees.

Above Pagan, the Shan-Kadoos inhabit the river banks. They dress like Shans or Burmans. They wear silver ornaments. Their houses are like those of Shans, and they speak both languages. They are Buddhists. They plant gardens; also *toungya* or hill cultivation and *kaing* cultivation on the river banks, the latter consisting of tobacco, brinjals, cucumbers and pumpkins. On an island above is the Kadoo village of Hnote-cho-kyoon. The Burmans appointed a thoogyee there, who levies as much revenue as he can.

This village and another on the island refuse to acknowledge the authority of the Kachins, which they can do with impunity, being on an island.

The Shan-Kadoos also cultivate rice. They trade with the Kachins and with Bamo. They import salt, clothes, betel boxes, &c. Some live by washing for gold.

The villages along the river bank pay revenue to Burma, a thoogyee being stationed in each village; they also pay to the Kachins, who indent on them whenever sacrifices have to be made.

Below Ka-cho there is a plain inhabited by Kantees,—emigrants from the country at the western source of the river. On their first arrival they asked permission from the King of Burma to settle. Their dialect is different from Shans. Their houses are like those of Shans. The women dress in black and blue. They have a short jacket and a petticoat with a high waist. They tie their hair in a knot on their heads a little to one side. They are Buddhists.

The reason of the emigration was that there were two powerful sawbwas, Lone-kyeing and Loke-koon, who had a dispute. The former being defeated came down here and is now a subject of Burma.

The Loke-kyeing sawbwa sends a yearly present to the King of Burma of an elephant or something else to show his respect, but pays no revenue.

Above Ta-law, up the Nam-malee and Nam-tabet streams, some Shan-Tarokes (Chinese-Shans) live. They are also scattered about along the river bank. They grow opium and cultivate the low lands. Men and women wear black clothes and pig tails. They speak Shan and Chinese, and, although Buddhists, men, women and children drink spirits. They have two kinds of priests, one like a poongyee, and the other eats at any time and drinks spirits and smokes opium, and, except for the priestly garment, is undistinguishable from the people. These Shans build their houses on the ground like *Kalas* (Natives of India). The Kachins not only inhabit all the high lands, but they have homesteads also on the river bank.

In Tasaing are ten Kachin houses. They only go in for hill cultivation. They manufacture opium. Men and women wear very little clothing. The women's jackets have no sleeves. They wear cowries as ornaments round their waists and beads round their necks, and bangles, made of cane dyed black, round their ankles. They use leaves for plates. They are not cleanly, but eat and live like pigs. They have no cups or plates or knives or spoons. They have nothing in their houses. Their cooking-pot is either a large iron vessel brought from China or else of stone. Sometimes they boil their food in bamboos, and they use these solely for water.

Their marriage customs are peculiar. A rich man has four or five wives. When a man's father dies, the son has to take all his wives, except his own mother. When a son dies the father has to give a substitute, his second son or some relative, or else has to take his daughter-in-law to wife. The custom is that a woman once in a family must not quit it.

Every family has slaves, between whom and their masters and mistresses there is no difference made; they do the same work, and all eat together the same food.

They smoke opium every day. Men, women, and children drink fermented spirits every day, made from rice in their own houses, just as Chinamen drink tea. The spirit is called *Koung* and *Chet*.

If any one gets ill they say that the *Nats* have caused it, and they sacrifice extensively on these occasions. They wear very dirty clothes. Pinpa and Sanka and other villages along the river bank are occupied by Kachins, who know a litte Burmese and Shan. About 20 or 25 people live in a long house, which has a number of rooms in a line. There is a fireplace in each room at which they cook, and in the common passage outside the room, there are some fireplaces round which they sit and smoke opium.

When Maing-na is passed, the country is peopled entirely by Kachins. First come the Kansa Kachins, and after them the Kan-loung Kachins. The latter have very little communication with strangers, and their custom apparently is for no one to visit the hill who is not a friend of the sawbwa, or whom the sawbwa does not meet and lead in himself; hence their suspicion of the travellers. To the east are the Maroos, a tribe of Kachins. These extend northwards to the water-shed of the Irrawaddy. To the east of them again are more Kachins. A village is always called by the name of the hill (poon) on which it is situated. Evey hill has its own sawbwa. To him presents are given whenever the people sacrifice, which they do on every occasion. Any relation of a sawbwa can order the people about. They are obedient. Whenever there is a dispute with a neighbouring hill, the sawbwa gives the order before fighting takes place.

A custom is that every boy after reaching ten years of age carries with him a bag and a *da*. People carrying more than one bag are thought to have something secret with them, or money, and are apt to be robbed.

Their *pa-soes* (kilts) are five hands in length and very narrow. The turban is red or white; the jacket black or white; these they procure from the Shans in exchange for rubber, oil-seed and cotton. They can't weave jackets.

Some have a hair-knot. Some cut the hair short like *Kalas*. The women dress in the same short petticoat as the males, dyed black, and tied tightly with a string round the waist. Their jacket is ornamented with shells; also strings of cowries are tied round the waist. Some rich men's wives are tattooed in bands from the ancle to the knee. They wear red and white beads round the neck. They never trade. If they are in want of salt or ngapee or anything, they go to a Shan village and exchange oil-seed, or rubber, or yams, or cotton for whatever they want.

In the hot season sometimes 30 or 40 men will make an excursion to a distance of nine or ten days' journey to some village, from whence, having killed or driven off the men, they carry off all the children and sell them as slaves, exchanging them for opium or cattle. They have no compassion and act as brutes, and when they have a dispute the stronger kills the weaker, seizes the wife and children, and sells them. A rich man, a sawbwa, has 40 or 50 slaves; a poor man, four or five only. The Burmese style this Kan-loung race "robbers." When a big man goes to make a raid, he does not require money to enlist his soldiers, but they get as pay four or five ticals (weight of over five rupees) of opium each. If they take captives they never torture them or ill-treat them, but feed them well until the time comes for killing them, when they cut off their heads with a *dâ*. Among the Kansas the sawbwas receive presents or bribes. Among the Kan-loungs there is no such custom as for the subject to give anything to the governor or sawbwa. The King of the Kan-loungs lives in Nga-kone-lapoon. He is young, and is apparently acknowledged as supreme, and without consulting him nothing of importance is undertaken.

The hills are described as devoid of large trees, and the population is so dense that the same fields have to be cultivated three or four years in succession. They cannot grow enough rice for themselves, and have to eat Indian-corn and yams and arums in the rains. They grow a little tea too. The hills are covered with cultivation and *Ficus elastica*.

The explorer speaks with admiration of their roads, which they make in zigzags up steep hills. The land is very moist and fertile, and they evidently have a perfect system of terracing, for he says they grow rice all up an almost perpendicular cliff. Snow falls, the climate is cold, and water is found on all the hills at the top. I am telling the story just as the explorer relates it.

When a marriage takes place, the bride has to give presents to the parents of the bridegroom. The explorer says that in the morning all the food for the household was cooked in a large vessel, and then each man's share wrapped up in leaves and made over to him. The explorers got their shares with the rest.

Whenever they sacrifice animals, they always hang up the horns on the steps or at the door. When a Kachin dies, four or five days' revelling takes place and cattle are sacrificed. He is buried under a mound. A ditch seven or eight feet deep is dug round, a tree planted on his grave, and a pole stuck into the ground with the horns of the beasts sacrificed, hung up on it. Their music consists of a very long drum beaten slowly, to the sound of which the young men and women dance.

One sawbwa was met with long hair (four feet long) tied in two plaits and wound round his head like a turban, in the middle being a hair-knot formed with some more of his hair.

One Sa-goo-noung, a leader of soldiers, showed them a snake's head, with two horns, one inch long, pointing backwards.

The sawbwa who governs the Mo-goung-maing-koung-poon, by name Sanouglee, has a black stone of a flat shape, something like a hand. It is always moist, and whenever put on one side turns on the other of itself. It is said that when he first got this stone it was about 40 tolahs in weight. Now it has increased to 80 tolahs; it has also got bigger. If it is kept in a cloth, the latter in time becomes full of holes, and it is supposed it eats it! The explorer was taken into a room and shown this wonderful stone, which is supposed to have life.

The Kansa and Kan-loung tribes of Kachins are divided into the following sub-classes: Lapake, Lasee, Lakoon, Lathoung, Sadan, Kara, Kakoo and Yoyin. The above all speak the same language.

The Maroo tribe are divided into the following:—Lamna, Malan, Lawin, Lapouk and Kalan. These speak a different dialect from the Kansa and Kan-loung sections, and are said to be a simpler, quieter, race, and do not commit the same barbarities as the latter.

The following materials were available for the compilation of the map:—

The river has been actually reconnoitred to about 60 miles up its eastern branch when it was last seen. The latitude of Mo-goung-poon, the termination of the explorer's route, is 26° 08′ as obtained by a double altitude of the sun when on the meridian.

The latitude and longitude of Bamo have been taken as 24° 16′N., and 96° 53′ 47″E. The latitudes of Poot-tay stream, Haw-ka village, and village Ka-cho have been determined by observations to four or more stars.

On a graticule on the scale of eight miles to one inch, Bamo was projected; also the other three points, whose latitudes are determined in longitudes adopted from the published maps of the river in the given latitudes.

From Bamo to Poot-tay stream the map has been compiled simply from notes made by the explorer.

From Poot-tay stream to Haw-ka and from Haw-ka to Ka-cho bearings and distances by time were recorded, and the plots of the route agree wonderfully between fixed points, and with the aid of the explorer are fitted in with considerable accuracy.

From Ka-cho the route has been plotted by bearings and paced distances. 3° 30′ has been deducted from every observation for the variation of the explorer's needle; the latitude of the termination of the route is checked by the observed latitude of Mo-goung-poon, and it agrees so nearly (within a mile) that the plot is left unaltered.

The height of Ka-cho above sea-level has been obtained by two boilings of the thermometer on the 2nd and 9th December. The final height is 1,020 feet, the temperature of the air on the two occasions being 65° at 9 A.M., and 71° at noon.

No opportunity occurred for ascertaining the temperature of the boiling point again.

At Mo-goung-poon at the end of January, at 9 A.M., the temperature of the air in the shade was 66°.

The following is an abstract of latitudes :—

Locality.	Star observed.	Resulting latitude.	Final latitude.	Remarks.
		Deg. M. S.	Deg M. S.	
Poot-tay stream	α Piscis Aus.	24 53 37	.....	
	β Ceti	24 53 45	.....	
	α Ursæ min.	24 50 43	.....	
	α Persei	24 55 15	24 53 26	
Haw-ka village	α Piscis Aus.	25 5 32	.....	
	α Canis maj.	25 5 19	.....	
	β Cœti	25 5 24	.....	16th November 1879.
	β Ceti	25 6 14	25 5 37	17th ditto.
	β Orionis	25 9 53	.....	Observation rejected.
Ka-cho village	β Orionis	25 19 31	.....	2nd December 1879
	Ditto	25 19 56	.....	3rd ditto.
	α Canis maj	25 19 51	.....	
	β Ceti	25 18 57	25 19 29	
Pouk-san hill	⊙	.....	.....	An observation of the sun was taken, but it is rejected because it was interrupted.
Mo-goung-poon hill	⊙ Upper limb	26 14 17	.....	
	Ditto	26 8 3	26 8 8	This observation is adopted instead of the mean, because the observer states he has more confidence in it. The difference of over 6 is the result of want of practice in observing the sun which could not be obtained in Rangoon.

In the Kachin country, in addition to the names of the villages or hills, I have given the governors' or sawbwas' names, as they appear to be as much known by the one as the other. It will be seen that the eastern branch of the river splits up again into two branches. The sources of these have been placed on the maps as they are for the following reasons :—

At Mo-goung-poon Maing-koung, the sawbwa said that six days' journey from that place the river ceased. A 'Kachin' day's journey is taken at eight or ten miles, as according to the explorer that is what these people travel. The sawbwa pointed in the direction the river flowed. He said he had been there. When the saya, who was present, mentioned the lake, he said he had not been in that direction.

He said the Maroos extended as far as the river. After them and beyond the river came a people wearing white clothes and speaking an unknown language.

At Main-goung-poon the sawbwa, of the same name, said he formerly lived at Sakee-poon, and had been to where the river ended at five or six days' journey from his former house.

The saya of Ka-cho village, who accompanied the explorer onwards from there, stated that when the Panthays and Chinese ('China-gyee' as he called them) were at war, he went with a hundred men to take part with the latter.

When the war was over he remained several months among the Chinese, and had been up to the lake called "Nounǵsa," which he said was so large he could not see across it. He stated that a river flowed out of it to the west; that he was sure it was the Irrawaddy on account of the direction of the flow of the water.* The explorer first heard the Saya talk of the eastern branch of the Irrawaddy as the In-myit, meaning 'Lake river,' which made him enquire why he called it so. He said there were no hills near the lake, so it would appear to be on an elevated plain. He described the country about there to be well peopled with Shans and Kachins. The longitude of the lake is approximately obtained by the distance to the Chinese territory being invariably given as about six marches from the Irrawaddy. I may have put it too close. There is a snowy peak on the map, but this has snow on it only in the coldest weather I conclude. The eastern branch of the Irrawaddy is styled by the Shans 'Myit-ngeh' or 'Little river,' the western branch 'Myit-gyee' or 'Big river.' The Kachins call the two branches Meh-ka and Malee-ka.

* This information was confirmed by a man of Zee-gyoon who also had been there, but whose name he has forgotten.

At Ka-cho the explorer heard that it was from 22 to 24 days' journey to Kantee, near the sources of the western branch. At Mo-goung-poon he heard that it was from eight to ten days' journey to the same place. At Mo-goung-poon Maing-koung he heard from the sawbwa that northwards from where they were the distance across from one branch of the Irrawaddy to the other was only one day's journey.

An important fact was observed by the explorer, from which some conclusions can be arrived at One perhaps is that the eastern branch has not its source in the snows, or if so only a small branch of it. One thing is evident, that the first melting of the snows flooded the river from its western source, whereas the other smaller branch was not affected but was daily drying up.

On the 16th January near Maing-na the explorers noticed the river unusually flooded, and heard their companions say this was owing to the melting of the snows.

They then gradually struck off from the river, as will be seen from their route on the map. On reaching the eastern branch, where they had to cross it, there was no sign of a flood. They re-crossed at the same place on their return journey on the 18th February, and they noticed that the water had receded about a yard from the stone on which they had rested at its edge on their former visit. On the 21st February, when they came in sight of the main stream again, they were surprised to see that the river was not only in flood but double the height that it was the first time.

These observations show the intelligence of the explorer, and I think if all he heard and saw is put together, it may be concluded that the main branch of the Irrawaddy is the western, and that Wilcox's proud boast that he had discovered its source in 1825 has after all turned out to be true, and that all theories about the Sanpo being the Irrawaddy may be for ever abandoned. It is possible the Noungsa lake, said to be of great size, may account for the enormous rise of the Irrawaddy in the rains. Also it is possible that Wilcox though he thought himself near the source was not so in reality, and that the river takes its rise higher up in Thibet, but that it is the Sanpo is more than improbable.

NOTE.—Since writing this report I have received from Mr. Burgess a copy of the gauge register of the Irrawaddy river kept at Myanoung main gauge during January, February and March 1880.

I see by it that the river was falling steadily till the 20th February, on which date it began to rise, the readings being on 19th February 1·58 feet, 20th February 2·17 feet; it fell again from the 3rd March to the 22nd, when it began to rise and continued to do so till the end of the month.

The gauge reads 40 feet at the high flood mark of 1875. I asked for this information out of curiosity, to see if the flood noticed by the explorer in latitude 25° 30′ was appreciable down here. I hardly expected it would be, but it is satisfactory to find that the river did begin to rise on the 20th February and on 22nd March, and continued to do so.

Translation of the Explorer's notes, appendix to CAPTAIN J. E. SANDEMAN'S *report on the* IRRAWADDY RIVER *Exploration.*

ABOUT eight miles above Bamo there is a place called Kyouk-twin because of the high floods there during the rains. There are great mountains on either side, and in the middle of the river there are many large rocks which bar the passage. Between these rocks there are most violent whirlpools. During the rains boats going up and down cannot use their oars. They must go by means of tow-ropes. Many people perish here every year through the destruction of their boats.

The people who live on the right and left banks along the whole course of this Kyouk-myoung are called Poons. From Tha-pan-bin to the village of Pagan there are nine villages, containing altogether some 150 houses. The inhabitants live by cultivating *toungyas* and cutting bamboos. There are no tillers of rice-fields. These people have a tongue unlike the Shan, Kachin, or Chinese language. The men dress as Burmans and the women as Shans. Their houses are like cow-sheds; and they are in the habit of wearing very filthy garments. The Burmese authorities take from them what revenue they think proper. Various Kachin sawbwas rule over them. When a Kachin sawbwa wants to make offerings of cattle, pigs, or poultry to *Nats*, he makes demands on these people, who have to furnish what he requires. When a Kachin under the ruling sawbwa dies, each house must assist by furnishing a man with a *pyee* of rice, a quarter-rupee, a spade, and a *da*. These Poons are Buddhists. They study Burmese and Shan literature. After the manner of the Burmese, they build monasteries and worship the sacred clergy and images.

Above the village of Pagan Kyouk-twin there is an island called Hnote-cho-kyoon. Shan-Kadoos live on this island. The men dress as Burmans and the women as Shans. The women wear silver bracelets and gold earrings. These people build houses like the Shans and Burmans. They speak Shan and Burmese, and are Buddhists. They cultivate orchards, *kaings*, and *toungyas*, and live by trade. There is an upper and a lower village. The Burmese have appointed a Thoogyee, and levy what taxes they think proper. The islands do not submit to the authority of the Kachins, for the Kachins cannot attack them, since they are surrounded by water.

Above the island of Hnote-cho, Shan-Kadoos live in Shway-in, Tahaw-na, Kone-tha, and Hantha villages up to the city of Ayeing-dama. They cultivate rice-fields, *kaings* and *toungyas* and trade. The men dress as Burmese and the women as Shans. They speak Shan and Burmese. The Burmese have placed a Thoogyee in each village, and they levy what they think proper in the way of revenue. They are ruled by various Kachin sawbwas, to whom, when asked for cattle, pigs, poultry, or rice for offerings to the *Nats*, they must furnish what is required. When a Kachin dies, each household must send a man to assist with a *pyee* of rice, a spade, and a *da*. These Shan-Kadoos are Buddhists, and like the Burmese they build monasteries and worship the sacred clergy and images.

Ayeing-dama is an ancient capital city, and there is something still left of the walls and ditch. Up to the reign of King Bodaw Paya, a road between it and China was open and traders dwelt there, carrying on constant traffic and trade by means of pack bullocks and mules.

There is an extensive plain here where existed rice-fields formerly. Timber does not grow here even now. The plain is in its former state. Were industry established here afresh, a great and most flourishing city would spring up. There are now some 20 Shan-Kadoo and some five Kachin households, governed by one Done-ngoo, a Kachin sawbwa. The Shan-Kadoos pay revenue to the Burmese Government; but the Kachins do not. Kachins do not pay revenue to the Burmese on whatever part of the river they may dwell; they are called savages and are let alone.

Above Ayeing-dama are the villages of Ka-yone, Haw-ka, Koung-boo, and Ta-law, inhabited by Shan-Kadoos, who live by tilling the soil. There are extensive rice-fields. The men dress as Burmans, the women as Shans. The women wear silver bracelets and earrings. Like the Burmese, they build monasteries and worship the clergy and sacred images. These villages are governed by various Kachin sawbwas. The Burmese Government also have appointed a Thoogyee to each village. The Burmese levy such imposts as they think proper. When we arrived at Ta-law, the sawbwa of that village had been seized and killed by a Kan-loung sawbwa. The village is governed by Kan-loungs. Some of the inhabitants of Ta-law and Koung-boo live by washing for gold.

Above these villages there are two streams, named the Nam-malee and Nam-tabet streams. Shan-Tarokes and Shan-Kadoos live there. The villages are governed by Kan-loung Kachin sawbwas. The Burmese Government take revenue from the Shan-Kadoos. The Shan-Tarokes and Kachins grow poppies and make opium. They cultivate rice-fields and *toungyas*. The Kachins smelt lead. Lead comes abundantly from the streams. There is a road open to China, and Chinese merchants constantly traffic and trade in this metal. The lead is exported to Burma also.

A Kantee chief left his country, with the intention of not returning, to become the vassal of the King of Burma. He said that he was a hereditary sawbwa; and asking permission of the Burmese King to establish towns and villages, obtained a Royal Order This chief has now established himself above the Nam-tabet stream in a large plain. The Kantees speak a language of their own. Their houses are like those of the Shans. The dress of the men is like the Burmans. The women wear garments dyed blue and black, sewn up in front like lonegyees, and silver bracelets and earrings; and their hair-knots are worn over the middle of their crowns, flattened out and twisted round. These people are Buddhists, and like the Burmese worship the clergy and images. In the native country of these Kantees the sawbwas of the Lone-kyeing and Loke-koon tribes being at enmity with each other went to war, and the Lone-kyeing sawbwa fleeing on defeat, the Loke-koon sawbwa at present governs in the Kantee country; while the Lone-kyeing sawbwa, becoming a vassal of the Burmese King, has now established villages and towns. The Loke-koon sawbwa must present yearly gold and silver flowers to the Burmese King. He does not pay revenue, and he levies what dues he chooses from his people.

Above this Kantee village is the village of Ta-saing, consisting of about 10 Kachin households. The inhabitants cultivate *toungyas*. They grow poppies and make opium. The men wear waist-cloths (*nau-ngeh*). The women also wear waist-cloths, which they tie around them with waist-bands. Above they wear loose jackets with short sleeves. At the waist they wear girdles made of cowries threaded with rattan. On the neck they wear white and red *loke-taw* beads. Above the calf up to the knee they wear hoops of rattan dyed black. On the head they wear coarse cotton cloth, some four cubits long, as a turban. They wrap up their rice in green leaves, and eat it on leaves. Their curry is also eaten on leaves. They are dirty in their eating and drinking. They have no such things in their houses as bowls, plates, spoons, cups, *okes*, and *dounglans*. They drink water out of bamboo tubes. With regard to their customs: if a father dies the son takes possession of his father's wives, except his own mother, and makes them his wives. If the son dies, a substitute must be given to the son's wife. Should there be no relation to give as a substitute, the father takes possession of the daughter-in-law and makes her his wife. If the elder brother dies, the younger brother takes possession of his wives and makes them his own; and if the younger brother dies, the elder brother does likewise. The unmarried young men and women, so long as they are not brothers and sisters, act like the brutes. The people smoke opium daily. *Kazaw* and *koung* liquors are prepared at home by the women, and drunk by old and young, men and women. If any sickness befals them, they say they are *Nat*-seized; and having killed cattle, or pigs, or poultry, and saying that they are offering to the *Nats*, old and young, men and women, assemble and eat and drink. They are very filthy in their dress.

Above this place is the old town of Maing-maw, which contains some 20 or more Shan-Kadoo houses and five Kachin houses. The Shan-Kadoos cultivate rice; and the Kachins cut *toungyas*. The Shan-Kadoo men dress as Burmans and the women as Shans. Like the Burmese they are Buddhists, building monasteries and worshipping the clergy and images The Shan-Kadoos pay revenue to the Burmese. Maing-maw was formerly established by a great Shan sawbwa who lived there in great state The plains where formerly there was rice and other cultivation are still unwooded. There are some remains of the city walls and ditch. If a city be established here, it is likely to become great and flourishing.

Above Maing-maw is the village of Pa-law, containing some 20 or more householders of Shan-Tarokes, who live by rice cultivation. The men wear trousers like Chinese. Some wear their hair in a tuft, and some do not. They wear black jackets and black turbans. The women wear black cloths like *loneggyees*. They have, like the men, turbans on their heads. They wear bracelets and ear ornaments of silver. They build their houses like *Ponena* (Hindu) houses by raising up the ground. The men and women, young and old, drink liquor. They speak Shan and Chinese, and are Buddhists. They have two sects of clergy; one, calling themselves the "forest church," behave like the Burmese clergy; the other, calling themselves the "*Pweh* (feast or assembly) church," eat their rice morning and evening and drink spirits and smoke opium. These last act like the people, differing from them only in their dress.

Above Pa-law are the villages of Pin-pa and Sanka, inhabited by Kachins. They live by cultivating *kaings* and *toungyas*. They grow poppies and make opium. These Kachins, because they live on the banks of the river, know a little Shan and Burmese. The Kachins, according to Kachin custom, build houses, and roof them as if they were roofing imaginary boats, the roofs being of the same form as those placed on large boats. The men and women, young and old, drink liquor. The men also smoke opium daily. If they are attacked by sickness, they make offerings to the *Nats* by the sacrifice of cattle, pigs, or poultry.

Above these villages, on a large plain, Kantees have established themselves in towns and villages. In Kantee, the native country of these people, the hereditary sawbwa of some 5,000 odd households died, and his sons being unable to support themselves left their native place, and presented the late Burmese King with a live musk-deer, gold and silver flowers and other gifts, and prayed to be allowed to become vassals without prejudice to the succession of the Loke-koon sawbwaship. Having obtained a Royal Order to establish towns and villages, and live on the confines of Burmese territory, they established themselves some 10 houses with 50 odd houses of Shan-Tarokes in a village which they called Lweh-zaw on the Nam-yin stream. In 1239 (B.E.) the Kachins having made an invasion killed the Kantee sawbwa, and the remaining sons unable to stay there went and dwelt temporarily above Ka-cho. There, however, the elder brother of the dead sawbwa killed the man who acted as Prime Minister. The son of the dead sawbwa accordingly presented his sister to the present Burmese King as a "Virgin daughter," and obtained a Royal Order to succeed and establish himself, under the order previously given to his father, below Ka-cho. These Kantees dress—the men as Burmese and the women in cloths, like longyees, dyed blue and black. Their jackets also are dyed black. They wear their hair-knots over the middle of their head and twist their hair round.

The city of Ka-cho was formerly established by a great Shan sawbwa, Haw-peing, who came from Theing-nee city. This city of Ka-cho was a great city, and had to present yearly gold and silver flowers. A road was opend to China, and there was incessant traffic and trade of merchants of great and small degree by means of baggage animals. A sawbwa of these Shans established another city above Ka-cho, which was called Waing-maw. Another city, Maing-na, was established by another of these sawbwas above Waing-maw. Another Shan sawbwa established another city, Maing-maw, below Ka-cho. Ka-cho being made the principal city, there were four cities on the eastern bank of the Irrawaddy, Maing-maw, Ka-cho, Waing-maw, and Maing-na, established by four sawbwas living in great state after the Shan custom in places called by them "Haws," and building walls and ditches. They thus dwelt for a long time, submitting yearly gifts of gold and silver flowers, but not revenue. Subsequently, during the reign of Aloung-paya-gyee, when the Talaing and Yodaya (Siamese) kingdoms were attacked and taken possession of, they followed as Shan generals with a contingent of a thousand men. When victory was obtained they asked leave of the Burmese King and went back. While trading and trafficking in their own cities, they sent during Bodaw Paya's reign, a Burman as their messenger with the usual gold and silver flowers for submission to the King and expenses for the journey. But this Burman took away the offerings and went elsewhere, wherefore the Burmese King gave orders for an expedition against them, saying that the four Shan sawbaws were rebels in that they had not presented the usual tribute. Accordingly the Burmese King's generals set out with men, arms and ammunition, simultaneously captured the four cities, arrested the sawbwas, and captured and killed many, old and young, men and women. Thus the towns and villages were destroyed; and although there are people living here now, there are not so many as before: there are but few. The city of Maing-maw contains 20 odd households, Ka-cho city 80 odd, Zee-gyoon 50 odd, Moke-lway village 20 odd, Thagara 30 odd, Waing-maw 40 odd, Ywadaw 20 odd, Thayagone 20 odd, Myitkyee-na 30 odd, Noungta-law 20 odd, and Maing-na 30 odd. Their inhabitants are Shan-Kadoos; and old and young, men and women, are able to speak Shan, Burmese and Kachin. The Burmese

Government has appointed a Thoogyee at each of these places, and over these Thoogyees a Myo-oke, called the Lay-myo-oke (Four-city Myo-oke).

The inhabitants are Buddhists, building monasteries and worshipping the clergy and images. The Burmese take what revenue they think proper. They are governed also by different Kachin sawbwas. When a Kachin sawbwa makes demands for offerings to the *Nats*, they must give cattle, pigs, or poultry. When a Kachin dies also, each house has to furnish a man with a *pyee* of rice, a *da*, and a spade.

Of the above villages, the inhabitants of Ka-cho refuse to subject themselves to the authority of Kachin sawbwas: they pay revenue only to the Burmese Government. They till rice-fields extensively. The inhabitants of the villages above Ka-cho are some of them rice cultivators. Some associate themselves with merchants, interpret and carry on negotiations, and act as brokers. There are extensive plains here where formerly cultivation was carried on. If the city be again established, there is a likelihood of its being great and flourishing. The soil here is exceedingly good.

To the east of Waing-ma, on the Nam-yin stream, some 30 odd households of Shan-Tarokes live by cultivation. They are governed by Kachin sawbwas, who levy an impost on the paddy cultivated. They have not to give any revenue to the Burmese Government. There are traces up to the present time of extensive paddy cultivation along the right and left banks of this stream.

Above Kyouk-twain on the Irrawaddy, from Ayeing-dama up to the sources of the stream, the Kachin mountains, gold is to be had by washing wherever a sandbank appears. Above Bamo from Tha-pan-bin to Haw-ka is wooded plentifully with teak trees. There is much excellent timber here along the course of the river up to the sources of the stream where the Kachins dwell. India-rubber is very abundant. It is still more so where the Kachins are.

On the Irrawaddy river Shans live as far as Maing-na village. They pay revenue to the Burmese Government. Above Maing-na there are no Shans or Burmans. The Burmese territory ends at Maing-na.

Above Maing-na the Burmese do not own territory. The Kachins severally dwell with hill-chiefs of their own. Going up the main stream of the Irrawaddy to the North-East, boats, eight fathoms in length, can proceed about three miles, but beyond this they cannot. At this last boat-station there are no Shans or Burmans: there are only Kachins. Those only who understand Kachin can go, and they can only do so when the Kachin headmen come and meet and invite them. If they are not accompanied by Kachins, they cannot go. When the Kachins wish to come down, they construct bamboo rafts and come down. The river has two branches,—a right and a left. The left branch is called the Malee river, which means the 'Big river.' The right branch is called the Meh-ka, which means the 'Little river.' Above this Meh-ka or 'Little river' there are a great many boulders, rocks and reefs. Regarding the rise of the water: when I was going up, the waters had risen on the 6th waxing Tabodweh; but when I had crossed over to the "Little river" on the 13th there were no indications of its rise. I also questioned the ferry-man at the ferry, and he stated that the waters did not then rise. When I was returning I did not see any rise. The rise was in the Ma-lee ('Big river'). The reason of the rise is this. At the sources of the 'Big' and 'Little' rivers there are snowy mountains. The snow on these mountains melting becomes water, and the Burmese call the phenomenon *yay-myoo-to* (water-vapour-rise).

Above Maing-na dwell Kachins. First, sawbwa Souk-lee of the Ka-chaing mountains, then Laing-yan-moo, sawbwa of Laing-yan-moo-poon, Nga Kan-too of Laing-pouk-poon, Patone-wa, sawbwa of Pouk-san-poon, Souk-kan, sawbwa of Moon-koung-poon, Souk-moon, sawbwa of Mara hill, Marekka-tantoo-naw, sawbwa of Kate-tway-poon, Touk-lone-ka, akyeewa of Pone-ga hill, Wa-win-wa, Sawbwa of Nan-seing-yin-poon, Maing-doung-too, sawbwa of Marapoon. These people, who call themselves Kansa Kachins, have one governing sawbwa for each hill according to Kachin custom. As for their customs: followers, when they offer cattle, pigs, or poultry to *Nats*, must present a leg of each to their sawbwa. If the sawbwa be hereditary, young and old, women and men, attend to all his behests. When there arises any complication or quarrel between two hills, action is taken only when the sawbwa gives his commands. Young men from 10 years old always go about provided with a *da* and a wallet. They wear waist-cloths some four or five cubits long, and for turbans they wear *sha-ban-dee* cloths, red or white. They get their jackets by going to the Shans, and exchanging for them sessamum, India-rubber, or cotton. Some wear hair-knots. Some cut their hair as low as their ears. The women also wear cloths dyed black, four cubits long and two cubits wide, folded around their waists and tied with waist bands. The jackets are close fitting and over them they have a looser one with set cowries. On their waists they have perforated cowries threaded on hoops of rattan, some wearing three, some four, hoops. From their knees down to their calves they wear hoops of rattan. Some women, the wives of the principal men, tattoo their legs from the knee to the ankle. They wear also red or white *lake-taw* beads. The men daily smoke opium. *Koung* and *kazaw* liquors are made by the women at home, and drunk by men and women, old and young, daily. The men do not understand trade. If they have no salt or *ngapee* to eat they go to the places of the Shans and Burmese and get them by bartering with sessamum, cotton, India-rubber, arums, or yams. During the summer some of these Kachins collect together in bands of 30, 40, or 50 and go to some Shan, Burmese, or Kachin village which they can overpower, which is distant some eight

nine, or ten days' journey, and besiege and set fire to it; and when the inhabitants come out, the grown up men are cut down and killed, and boys and girls from two to 11 years old are captured and exchanged for silver, opium, cattle, or any other thing they require. They have no compassion for human beings: they act like brutes. If there be one who quarrels with another, he who is victorious kills him who is conquered, and seizing his wives and children goes and sells them to another. If a man is fairly well to do, he has three or four slaves. Sawbwas and the chief men have each, according to their power, 10, 20, 30, 40, or 50 odd male or female slaves. Regarding the work of the slaves: they do not have to work separately: they work together with the master of the house or his sons and daughters. When they eat and drink also, the master of the house does not eat good food separately by himself; the slaves and the master eat together.

At Marawa hill, the territory of the Kansa Kachins ends. Beyond this territory the Kan-loungs dwell, viz. Chief Sa-goo-noung on Kansan-poon, sawbwa Mawloowa on Mawloo-poon, sawbwa San-oung-lee on Mo-goung Maing-koung, akyeewa Pouk-lee-shoung on Tone-poon hill, sawbwa Laboola on Sakee-poon, sawbwa Laboo-shoung on Sin-poung-poon, sawbwa Saramatee on the See-hnin (snowy) mountains. The King-Sawbwa of the Kan-loungs, Maran-gyee of Nga-kone-la-poon, died and was succeeded by his son, La-baing-ka-shin-teing-nan, who now exercises governing authority. The Kan-loung Kachins are so called from being separated from the other Kachins, their name meaning "acknowledged rebels." The sawbwa Ma-ran-gyee is more mighty than all other Kachin sawbwas. He is wise in his speech; his designs, conceptions, and plans are good; he has many adherents, and is able to govern many. Being acknowledged by many, he attacked, captured, and killed the neighbouring sawbwas, and appointed such men as he deemed fit to govern as his lieutenants. His possessions thus increased from one hill to another, lieutenants being appointed to govern each hill.

The jurisdiction of (these) Kan-loungs extends on the east to Sakee-poon and Sanka-poon; on the west beyond the Ma-lee or 'Big river,' on the south to Marawa hill, the territory of the sawbwa Souk-kan; on the north to the confines of the Kanti territory. As these people form a large tribe, they commit raids year by year. When about to make war, expenses in the shape of money have not to be given. The chiefs assemble large numbers of men, and by giving to each four or five ticals, as the case may be, of opium, cause these large numbers to follow and attack and destroy. When victory has been obtained, the grown-up inhabitants of the conquered village are put to death, and the youths captured are sold by each captor. Over the village thus overcome is placed a lieutenant to govern. These lieutenants do not, like the sawbwas of the Kansa tribes, exact legs of cattle or pigs from their subjects. Should there be any business, they have first to obtain the orders of the Kan-loung King, Labaing-ka-shin-teing-nan, before they can order or act.

As there is not sufficient space for cultivation in the region inhabited by these people on account of their large numbers, they have to cultivate *toungyas* for three or four years successively in one spot. They do not get sufficient rice for food, and have to supplement it with arums, yams, vetches, and maize. Some, not obtaining a harvest from one year to the other, have, during the rains, to eat arums, yams, &c., instead of rice. They do not change their habitations from one hill to another. They are in the habit of dwelling in one place. Living as they have done for a long time, there are few large trees on the hills. Not a Shan or Burman visits their country. If he wishes to visit, he can only do so by making friends with the sawbwa, and the sawbwa personally coming out and receiving him, and personally following or accompanying him on his going and return.

Regarding the customs of these people: when a man and woman set up house, the man has to give to the parents of the woman, cattle, pigs, gongs, muskets, *das*, slaves, clothes (*paxos*), spears and money, and for his wife's use he has to give coral beads, *tamgines*, jackets, broadcloths, &c., according to his circumstances. If he is not able to give them on the spot, he has to give a guarantee that he will do so hereafter. After the gift, or the guarantee to make the gift, the woman is brought to the man's house, and the man has to feast the bringers of the woman with rice and curry, and spirits and liquors. To the elders also he has to give blue waist-cloths and *sha-ban-dee* turbans, *das*, or spears according to their degree. The man then shows the woman all the work to be done in the house, and bids her do the work. After having set up house for a long period, when the man dies, the woman cannot set up house with any other: the brother, elder or younger, has to set up house with her. If there be no brother, the deceased man's father (the woman's father-in-law) takes possession and makes her his wife. In the same way, if the elder brother dies, his wife is taken over by the younger brother, and *vice versâ*. If the father dies, the son takes over his father's wives, except his own mother, and makes them his own. If the first wife dies, the husband goes to his deceased wife's parents, and asks for another wife, and they must give him her elder or younger sister—a woman who is unmarried. If there be no sister to give, they have to give a female relative. A relative of the wife's is greatly respected, being styled "father-in-law's relation." When any such come, the son-in-law has to give property in proportion to their worth. Husbands and wives must not be at enmity with each other; there is no such custom as divorce. If the husband be bad, the wife cannot separate; and if the wife be bad, the husband cannot separate. If the husband wishes to do so, he has to give double the property he originally had to give her. If the woman wishes to do so, she has to give quadruple the amount of property originally given. If the man sets aside his wife and takes another, his head wife has the right to take possession of all the property of the younger wife, as

well as to sell her. The husband sells his son's wife's sons and daughters to somebody else. If the father dies and the mother sets up house, not with her husband's relative, but with some man who is not connected with the father, the woman's son, saying that she does not pay heed to her character, sells her. The young unmarried men and women, so long as they are not brothers and sisters, act as they please inside the apartments of the house.

Regarding the customs of these Kachins: when they sacrifice cattle or pigs to the *Nats* in the house of a big or small man, the skulls of cattle, with their horns, and the skulls of pigs, are carefully hung up for people to see in the front passage leading to the house, in proximity to the steps, or on the front post of the house. When a Kachin dies, he has a splendid funeral, and after cattle, pigs and poultry have been killed, all are feasted for three or four days with food and liquor. Young men and women come from one quarter to another, and surrounding the dead body dance and jump day and night. The body is interred in some sacred spot, which is surrounded with a trench about two feet broad and some three feet deep, and the centre heaped up like a small hill. The body is enclosed in a coffin. Posts are then erected and a roof carefully constructed. When the body is being interred, paddy, arums, flasks of *koung* and spirits, *das* and wallets, are interred with the body, and on the grave a post is erected, and the skulls of cattle and pigs are hung up for people to see.

On either side above the nape of the neck a certain Kachin has two switches of hair of the thickness of one's thumb and some four cubits long, each of which encircles the head three times. The top hair-knot as generally worn is also worn (by him).

The Lieutenant named Sa-goo-noung has a snake's head with horns of the thickness of the axis of a spinning wheel and about one inch long.

The Mo-goung Maing-koung swabwa, has a flat black stone, like a test stone, in shape somewhat like the palm of a man's hand, from which something like oil oozes. If the side where there are projections like the thumb, the fore, middle, and little fingers be placed below, and the side like the base of the palm above, the side like the base of the palm goes down and the side like the fingers erects itself shortly after without man's intervention.

Having arrived on the 2nd November at Bamo, we made enquiries regarding the road. We left on the 7th by boat, and on the 13th stopped at the mouth of the Poot-tay. I got out at night and took observations of the stars. When we arrived at Haw-ka village on the 16th, I took observations of the stars, on the 16th, 17th, and 18th. Leaving on the 20th, we halted at Ka-cho on the 23rd. We got ashore on the 24th, and put up in the house of a Shan saya.

We subsequently spoke like friends and sounded the saya about going to the sources of the Irrawaddy.

While living in this village I took observations of the stars on the 30th November; on the 2nd and 3rd December also I took the stars. On the 6th, 10th, and 11th I took the sun. The villagers were at variance with the Kachins, and at 8 o'clock at night the gates were closed, and every one had in turn to patrol armed. Moreover, a tiger had come and carried off pigs, dogs and poultry.

While considering how to go up, we met Nga Da, the Kachin swabwa of Paroo hill, made friends with him, and accompanied him; and having enquired about going to the sources of the Meh-ka, 'Little river,' and been informed by the Paroo sawbwa that there was no one who would go to the sources of the stream, we returned on the 23rd to Ka-cho.

The Ka-cho villagers told us: "Do not go up the Kachin hills. The Kachins are a very wicked tribe. We from our youth upwards have never gone up. We dare not go. We are exceedingly afraid." But we said to the saya of Ka-cho and the Pin-ba sawbwa, come and follow us, they replied: "No one from our village dare go, but if you sayas wish to go, we will, if you pay us, follow you as partakers in your good or bad fortune." Accordingly we started on the 15th January, and arrived on the 18th at Pouk-san hill. When in that village, it began to rain, and at night we could not see the stars on account of the clouds. On the 21st we took the sun; we left on the 23rd. On the 24th we crossed the Meh-ka or 'Little river' and arrived at noon at the house of sawbwa Marekka-tantoo-naw on Kate-tway-poon, where we stayed awhile to cook and eat food. This sawbwa is not like other men: he is a curious man. When young he had hair like ordinary people. When between 20 and 30, a confused mass of hair about the thickness of one's thumb grew on both sides of his head above the beginning of his back hair. This confused, twisted hair was not like hair growing elsewhere on the head; it was exceedingly intertwined, and could not be combed out. It grew day by day; and this man's age is 50 odd years now. This inter-twisted hair is about four cubits long on each side, and each side is bound round his head three times. There are altogether six encirclings of hair around his head. He has moreover his other hair worn after the fashion of all in a top-knot. His turban consists of nothing but his hair bound round.

With this sawbwa also we spoke amicably, giving him what presents we had, and making friends before we departed.

That day we slept at the house of akyeewa Touklone-ka on Pone-ka hill. With the Kachins of this village also we spoke amicably, departing as friends. On the 25th we slept at the sawbwa Souk-kan's house at Marawa. Here too we spoke amicably with the Kachins.

On the 26th we slept at the house of sawbwa San-oung-lee, Mo-goung-maing-koung hill in the territory of the Kan-loung Kachins. With the people of the village we spoke

amicably, gave presents, and made friends. On the 31st January and the 1st February we took observations, and on the 2nd arrived at aykeewa Pouk-lee-shoung's house on Tonepoon hill. Here we spoke amicably with the villagers, making enquiries as to the road, and so forth.

We accordingly had to come back, and on the 23rd November we reached Ka-cho.

Extract from a Report on operations connected with the survey of Gilgit, by LIEUT.-COLONEL H. C. B. TANNER, *Deputy Superintendent, Survey of India, dated 28th December* 1880

OBSERVATIONS with a theodolite have been taken at 17 stations, of which three belong to last year's work. 145 points have been fixed trigonometrically, and were computed whilst the survey was in progress. When the final computations are done, many of these points will be thrown out owing to their doubtful accuracy; and some new ones which have not yet been computed, will be introduced in their place. Owing to the rough nature of the mountain tops it has seldom been possible to use a stand, the theodolite generally having been set up on a well built cairn with a flat slab at top. Over the cairn the stones have been piled up so that each of the stations are well marked for future identification. When I say that I have fixed 145 hill peaks, I do not wish it to be understood that the points have the accuracy of those hitherto accepted by the Great Trigonometrical Survey. The apexes of some of my triangles are so acute, that an error of one minute at either of the ends of the base would make an error of ten miles in the position of the point. I hope, however, at some future time, to be able to improve the shape of the triangles, so that my points shall be true to a tenth of a mile. As to heights, a considerable number of peaks have been measured, but owing to cloudy weather some important ones have been observed for position only. On some of the peaks it was necessary to place the instrument at the very edge of giddy precipices, and then, sometimes, one only of the verniers of the horizontal limb could be read, and that with considerable risk and difficulty.

Beyond the mouth of the Warshigum River I could only see one village, Khalti, on the Gilgit River; but in longitude 72° 55′ 1 fixed two grand peaks near the source of the Shundas Lake, between which I could see the dip of the valley. The Ishkoman Valley drains a large area of glaciers, and joins the Gilgit River near Aish. The junction was mapped last year, and this season the course of the stream has been approximately traced for about 20 miles; beyond, it was lost to view amongst towering peaks covered with perpetual snow, which, from Guranjur station, the most northerly connected with the Great Trigonometrical Survey of India, stretch right across the westerly, northerly, and eastern horizon. Such a landscape as was presented to me from that commanding station, 17,200 feet above the sea, I am not likely to forget. To the north, two thousand feet below me, was a sharply defined watershed, from which a couple of glaciers took their rise, smooth at their origin, with a few crevasses parallel to the face of the mountain; lower down, riven into deep chasms, with green ice piled up between them in fantastic shapes. Beyond this rose immense naked needles, and saw-like ridges, backed up by a mass of lofty mountains averaging from 22 to 25,000 feet. At their bases are fields of snow, and a network of glaciers. There is here no single snowy range such as is presented by a distant view of the Himalayas when seen from the lower hills, but, instead, a vast wilderness of isolated mountains of every possible form, among which it is impossible for the surveyor to determine the lines of drainage. Far away to the west, more than a hundred miles distant, is the faint, cloud-like group round Tirich Mir, which attain from 24 to 25,000 feet: and to the north of that famous mountain, a very remarkable double peak in the Hindu Kush of more than 24,000 feet. Carrying the eye to the right is another high, rough peak, also in the Hindu Kush; and still further eastward, seen here and there, between the craggy mountains of Yasin and Mastuch, are the very rounded and smooth summits of the snowy mountains of the watershed of the Indus and Oxus. The view from Guranjur to the southward is comparatively tame, for in the Kaghan Hills and the Indus Gilgit Watershed there are few peaks of perpetual snow. One of them (T_{16} of the Great Trigonometrical Survey), which is only 19,000 feet high, stands up conspicuously from amongst its neighbours; to the eastward are the bold, high peaks of the Indus, among which are K_2, 28,000, and Nangaparbat nearly 27,000 feet. From Guranjur I observed a very high mountain to the north-west, which from its colour could not, I think, have been less than 80 or 90 miles distant, and if this distance be approximately correct, it must lie somewhere between the two branches of the Oxus, north-west of Sirhadd. It is possible that it may be one of the group depicted by Colonel Gordon on the sketch facing page 131 in his "Roof of the World." I unfortunately obtained no second ray to it.

The only guide one has in estimating the distances of remote snow peaks is their colour, far off snow always having a slight pink tinge, and though I have been sometimes misled, and have made considerable errors in guessing the distances of mountains, yet I believe I am right in supposing that I have seen two very high peaks beyond Chitral, and one beyond Sirhadd. The rounded forms of high snow-capped mountains is due to the constant piling up of snow on them when their summits are not too sharp; in some cases the apparent height of mountains may be increased by hundreds of feet; for in high altitudes, where the cold is intense, even the rays of the sun, powerful as they are in a highly rarified atmosphere, take several days even to form a hard covering over the freshly fallen snow. Even after two clear days I have seen the powdered snow flying in clouds off the upper slopes of Nangaparbat, and I doubt if snow melts at all at such an altitude,

Such mountains as K2, Nangaparbat and Rakhaposhi, are too sharp to allow the snow to lie on them in any quantity; it almost immediately descends to a lower altitude in the form of avalanches and then it gradually hardens and becomes glacier ice; but the great group round Tirich Mir have rounded tops, and this renders them sometimes difficult to intersect with accuracy.

In my last year's report I explained the difficulty in surveying the great flattened range which lies between the Indus and the Gilgit rivers. We have now obtained nearly all the topography of that remarkable region which is situated on the northern slope of its ill-defined watershed; and to the eastward, a small portion of the southern slope as well. It is an immense tangle of exceedingly sharp ridges, which zigzag about in the most perplexing manner. There are hundreds of peaks of nearly the same height, and so like each other, that after moving a few miles they cannot be recognized. I have eight stations in this tract which vary from 15,000 in the east, to 17,500 in the west Towards the head-waters of the Gilgit river the peaks assume bolder forms, and attain to 22,000 feet. One very marked feature in this range is the extraordinary number of mountain-lakes or tarns, which are found as many as three or four together at the sources of all the small feeders. I was encamped for a week or more at the head of a high valley, and here were three lakes, with a fourth in course of formation. Opposite my tent was a small glacier with one crevasse only, and a small moraine. The glacier was busy night and day in flinging stones down into the ravine and damming it up. Already it had formed a broad and extensive marsh, which at some future time will be a deep sea-green lake like the others. The uppermost of the tarns, which even in August was covered with little icebergs, had been made by the scooping action of ice, but the others were pent up by the moraines of small side glaciers which, owing to climatic change, now no longer exist. The lake region has an altitude of about 14,000 feet, and is wild and desolate owing to the scanty herbage and to the waste of mountain *débris* which is piled around; sometimes, when backed by high cliffs, these still, green pools are highly picturesque, and some few again, when surrounded by high crags and lofty rock needles, are almost grand. The Dards of Gilgit, who never ascend above the range of the Ibex, and who were very reluctant to accompany me into these wild solitudes, say that these holes and tarns were once the abodes of snakes and monsters, which were destroyed by one of their saints in years gone by. And I must confess that, without some knowledge of the action of ice, their existence in the minds of people who believe all the high and inaccessible places in the south to be frequented by spirits and fairies, is likely to be attributed to supernatural causes.

Some of the slopes above the level of the lakes, when seen from a distance, often present the appearance of downs of grey sand, but a closer view shows them to be composed of huge wedges, slabs and blocks of volcanic rock. Sometimes there occur whole ridges, of remarkably rounded form, which, from top to bottom, are made up entirely of such *débris*. A heap of broken metal, carefully patted down and rounded over, ready to be used for macadamizing our roads, is an exact miniature representation of these curious ridges. I, myself, cannot understand how these mountains have been so completely crushed and thus smoothed over, leaving not a single trace of the original rock *in situ*. In these regions the surveyor has often to travel miles over these dreary expanses of shattered rocks, which are often only just balanced one on another, and has to use the utmost agility to avoid being crushed beneath the tottering boulders which are ready to topple over at the slightest disturbance. When covered with even a thin covering of snow they are almost impassable and highly dangerous to cross.

I must not omit to mention the most interesting point in all this wild mountain region, which, in September last, after two unsuccessful attempts, I was so fortunate as to reach. I had long wished to obtain a near view of the northern slopes of Nangaparbat and of its glacier valleys, which join the Indus opposite the independent settlement of Gor, and after a most perilous passage over a narrow, rugged ridge, surrounded by enormous precipices, which tried my nerves to the utmost, I found myself confronted by what is probably the most magnificent snow view on the globe, embracing as it does a slope of very nearly 24,000 feet (vertical measurement), with its glaciers, snow-fields, ice-cliffs, and jagged needles of naked rock extending from the summit of this king of mountains down to the Indus, which flows in a deep channel at its base. My feeble pen is unequal to the task of giving any adequate description of this superb and impressive view which I contemplated from the edge of a tremendous precipice, whose summit is 16,000 feet above the sea, and which rises sheer and unbroken from the forests and vineyards of Gor, situated an immense depth below me.

The sharp peak of "Deo Mir," the "Mountain of the Gods," as it is called by the Dards, was distant just 23 miles, and the forest, which was seen as a sharply defined narrow belt, in which the pines could only just be distinguished, was less than half that distance; whilst the Indus, with its brown and sterile banks, was only seven miles off.

Without being a botanist, I have been able to make a large collection of specimens for my botanical friends, and I may as well give here a few facts relating to the distribution of vegetation in Gilgit. I will mention first that most useful tree the pencil cedar, which has a range in altitude greater than any other tree, for I have found it continuously from 14,400 feet down to 6,000. At the camping ground of Molcha, 8,000 feet above the sea, near Minowar in the Gilgit Valley, I found one specimen of this tree with a girth of 30 feet, measured 6 feet above the ground. It is still vigorous and healthy, and without blemish, and is supposed to be 300 years old, and is said not to have increased perceptibly in size

within the memory of man. Its circumference exceeds by many feet that of any other of its kind I have met with.

The *pinus excelsa** has a far less limited range, for it grows on the Gilgit slopes only, where the melting snows yearly leave a deposit of soil, with moisture sufficient to sustain vegetation throughout the summer; its range is from about 9,500 feet to 12,000, and that of the *abies smithiana*, which is found in less profusion, has narrower limits. The deodar does not grow in Gilgit, nor have I ever seen the *picea webbiana*. The edible pine, *pinus gerardiana* has already been stated by Drew to grow in Astor; it also is found round Chaprot, and thick forests of it grow just below Gor, and add greatly to the picturesque appearance of that settlement, for were it not for those trees, the slopes, which are too dry to support any other vegetation, would be brown and burnt up, like all the low ranges in Gilgit below 9,000 feet. The edible pine, *chilgoza* of the Afghans, may be said to extend from 7 to nearly 10,000 feet.

* The largest *pinus excelsa* I have measured had a girth of 14 feet, and a height of about 130 or 140 feet.

The birch is very common throughout Gilgit, it overlaps below into the belt of *pinus excelsa*, and grows as high up as 12,500 feet. Growing among the birch, and extending some hundred feet above it, is a very useful and widely spread shrub, which, with the exception of the pencil cedar, is the best fuel one meets with in these mountains; it likes marshy places, has brown, smooth, bark, and bears a small white flower which in seed time gives out a fine silky cotton. Though probably used by every Himalayan traveller, yet I have been unable to ascertain its botanical name.

The upper limit of Gilgit vegetation is pretty constant at 16,200 feet, where sometimes a few hardy flowers and a coarse grass may be met with in favourable situations. Above this the rocks are stained with grey and yellow lichens, but how high up the latter extend I know not. Besides the trees whose ranges I have above laid down, I should mention the *tamarisk*, which appears to thrive as well at 6,000 feet in the dry barren valleys of Gilgit, as it does amongst the oozy mud islands at the mouth of the Indus. It may grow above 6,000 feet, but I have not seen it myself beyond that. In the narrow belt of vegetation which contours so exactly round the Gilgit mountains are many wild fruits; wood strawberries abound, and at a slightly higher altitude are capital red raspberries; besides these, we have a small, sour, hairy, gooseberry, and a very nice green one, brushed with pink on one side. There are also black currants which have the flavour of red. On the margins of the watercourses in the low valleys there is a small sweet fig which is very good, and in the spring a red raspberry of insipid taste. I must refer those who require information regarding the flowers of Gilgit to Mr. Duthie, to whom I have given a large collection of dried specimens.

There are no oaks in Gilgit, and the wild olive is very rare; the slopes, which in other regions are clothed with those trees, being here sprinkled with that detestable plant the wormwood, with its overpowering smell. Its range is from 5,500 feet up to 11,000.

Before closing these hasty notes, I would wish to say a few words on the country beyond Hunza, which I was so lucky as to see from two of my high stations. My view extended to the watershed of the Yarkund and Shimshal rivers, where I observed two snow peaks of about 21,000 feet, just peeping up behind a wonderful array of lofty needles, amongst which—though I could not determine exactly at what point—the Hunza river makes its way. The Shimshal Pamir lies between the two snow peaks and the needles, and if my very feeble fixing of the former be at all correct, then the area assigned to that Pamir on the map is far too great. It is hopeless to expect any further extension of our trigonometrical survey in that direction, though perhaps I may be able to improve the shape of my excessively acute triangle, for my rays were taken through a narrow gap between Rakhaposhi (25,500 feet), on the western extremity of the great northern barrier of Cashmere, and a mountain of nearly equal height on the eastern end of the high range which separates Gilgit from Little Guhjal.

In the present disturbed state of the Dard races round Gilgit, it is impossible to say what survey operations we may hope to carry on during next summer, but should the Gilgit country be closed to us, a very considerable amount of survey may yet be achieved, by observing with a theodolite from one of the high points east of Bunji, and from another on the northern slopes of Nangaparbat west of Astor. If stations of over 19,000 feet could be reached, independent observations to all my high mountains towards Chitral could be obtained, and probably others could be fixed as well; but I must give a word of caution to any one who may attempt this task, and who may not have had experience in fixing high remote peaks. Tirich Mir, the greatest of the western mountains up to this time known, appears from my highest stations west of Gilgit as an exceedingly insignificant hill; indeed, until I had computed my triangles, I was not aware that I had been so fortunate as to fix that important peak; but from the Bunji range, distant over 160 miles from it, it would be exceedingly minute, and unless its position were exactly known to the observer before hand, it might escape his notice altogether. I may conclude by adding that though Tirich Mir is the highest mountain fixed by me in the far west, yet it is not nearly so important to geographers as the double peak in the Hindu Kush, about ten miles south-east of Varg in the Oxus valley. This mountain is over 24,000 feet, and has two well-defined points which rise out of two roundish symmetrical hills, which are nearly hemispheres. Though I have seen no notice by travellers of this commanding mountain, yet from its great height, and its position, probably in the very watershed of the Hindu Kush, it must be visible over a wide area to the inhabitants of Badakshan and Wakhan.

Extract from the Narrative Report, dated 23rd October 1880, *of* CAPTAIN A. W. BAIRD, R.E., *in charge Tidal and Leveling Operations.*

EVALUATION OF TIDAL CONSTANTS.

THE values of the several tidal constants which have been determined for various ports, from the harmonic analysis of all the observations which have been taken during the past year, will now be given.

The tidal constants are divided as usual into two groups—one composed of the short period tides, the duration of which in no case exceeds 24 hours; the other of long period tides, whose duration ranges from a fortnight to a year.

In the harmonic theory of the tides, the principal constituents of the short period tides are represented by fictitious stars, moving in circular orbits at certain known velocities—the arguments of motion—in the plane of the Equator. They are usually indicated by the letters S, M, O, K, &c. Each of these is, in its turn composed of a number of tidal constituents, also moving in circular orbits, but with different velocities, which are mutually related, those of the second and subsequent constituents being twice, thrice, or some integral multiple of the first. Their periods are determined in the following manner. When the revolution of the fictitious star is performed in, or about, 24 hours, the primary period is the one corresponding to the argument of motion of the star; when it is performed in, or about, 12 hours, the primary period corresponds to twice the argument of the motion of the star; the subsequent periods are fractions of the primary, corresponding to the multiples of the velocity. The tidal constituents after the first are sometimes called semi-diurnal, ter-diurnal, quarter-diurnal, and so on, and the smaller of these are usually called *Overtides.*

Every tidal constant is expressed numerically by two constants, viz. R, and ϵ. R denotes the linear value of the amplitude, viz. the semi-diameter of the orbit, which is equal to half the range between the highest and lowest levels of the constituents; ϵ denotes the angular value of the "epoch;" it may be defined to be the number of $\frac{1}{360}$ parts of the period—or number of degrees of the orbit—which any tidal constituent has still to execute from the instant when the fictitious star crosses the meridian of the place of observation to the instant when the constituent reaches its maximum.

The constants R, and ϵ, of the tidal constituents, are respectively distinguished by the subscripts 1, 2, 3, representing the relations of their periods to that of the primary period.

Three only of the fictitious stars, viz. S, M, and K, have more than one constituent of sensible magnitude. The constituent which causes any fictitious star to produce its greatest effect on the sea-level is rarely the first, and more frequently the second. The greatest effect of any single star is invariably produced by R_2 of M; afterwards usually by R_2 of S, and R_1 of K, to the last of which the phenomenon of *Diurnal Inequality*, which is so marked a feature in Indian tides, is chiefly due. The first significant constituent of MS is of the fourth period, amplitude R_4

The first constant in the table of constants for each port is A_0, which signifies the height of the mean level of the sea above the level corresponding to the zero of the gauge.

It may be here said, once for all, that the values of the linear quantities A and R throughout these tables are invariably expressed in English feet.

VALUES OF THE TIDAL CONSTANTS AT ADEN.

Lat. 12° 47′ N., Long. 44° 59′ E.

The following are the amplitudes and epochs evaluated for Aden observations, 1879-80:—

Short-period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*υ.*	*μ*	*MS.*	2 *SM.*
A_0 ...	5·768	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·073	0·050	1·368	0·716	0·389	0·128	0·100	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	167°·95	260°·85	118°·64	317°·43	301°·19	127°·58	318°·63	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·693	1·556	0·246	.....	.....	.....	.....	0·025	0·437	0·018	0·155	0·084	.....	0·022
ϵ_2 ...	248°·43	226°·48	229°·11	.....	.....	.....	.....	91°·77	220°·94	309°·74	239°·51	187°·77	.....	108°·44
R_3 ...	.....	0·019	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	216°·61	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·006	0·011	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·007	.....
ϵ_4 ...	263°·00	318°·06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	134°·43	.....
R_5 ...	0·005	0·006	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_5 ...	217°·78	337°·10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_6 ...	0·001	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	212°·01	79°·35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

Lunar monthly tide	...	...	$R = 0{\cdot}033$	$\epsilon = 4°{\cdot}6$
„ fortnightly „	...	...	$R = 0{\cdot}062$	$\epsilon = 354°{\cdot}5$
Luni-solar „	„	...	...	$R = 0{\cdot}014$	$\epsilon = 42°{\cdot}0$
Solar annual	„	...	...	$R = 0{\cdot}404$	$\epsilon = 2°{\cdot}7$
„ semi-annual	„	...	...	$R = 0{\cdot}110$	$\epsilon = 94°{\cdot}2$

The mean level of the sea (A_0) is slightly lower than in 1877-78.

The main lunar tide, R_2 of M, is slightly greater than in 1877-78, viz. 1·56 against 1·42. The main solar tide has also a somewhat greater amplitude, viz. 0·69 against 0·66. The epoch of both the main tides agree well with those of 1877-78.

With reference to the main diurnal tide R_1 of K, the amplitude is 1·37 against 1·32 of 1877-78, both of which are very high in value; its epoch also agrees well with what was formerly found.

The amplitudes and epochs of all the other tidal constituents agree fairly well with what was formerly obtained; but for the long period tides, the Solar Annual is 5 per cent greater in amplitude than for 1877-78, while the solar semi-annual is 50 per cent less.

The proportion between the two main tides for the year under review is about 1 to 0·45, which is very nearly the same as was found for 1877-78, when the proportion was almost exactly the same as that given by theory.

The proportion of the smaller lunar elliptic semi-diurnal tide (L), to the main lunar tide, is about one-half what theory would assign; whereas for 1877-78 the proportion nearly agreed with the theoretical value.

The proportion between the larger lunar elliptic semi-diurnal tide (N) and the main lunar tide, although less than in 1877-78, is still greater than the theoretical proportion, viz. 0·28 against 0·19.

The proportion of the evectional semi-diurnal tide (λ), to the main tide, is less than was found for 1877-78, but still it is greater than the theoretical proportion.

With regard to the other evectional tide (ν), the proportion to the main tide is about one-tenth, which is (3) three times as great as theory would assign, and 40 per cent greater than in 1877-78.

The variational tide (μ) has precisely the same proportion to the main tide as in 1877-78, which is more than double what theory gives.

The luni-solar declinational semi-diurnal tide (R_2 of K) is exactly the same in proportion to the main tide as obtained in 1877-78, which is slightly greater than the theoretical value.

The luni solar compound semi-diurnal tide (2 SM) in its proportion to the main tide is slightly less than in 1877-78, but agrees fairly well with what was obtained at Bombay.

But the main feature of the Aden tides is the large proportion which the diurnal components bear to the main tide, and this is again shown by the analysis of the 1879-80 observations.

The proportion of the solar diurnal tide R_1 of S is very nearly the same as that in 1877-78, which was double what obtains at Bombay, and about 50 per cent greater than that at Karrachi. It is remarkable that the proportion of this tide at Kárwár is nearly the same as at Aden, and only in two instances have the values obtained at other ports exceeded this proportion, viz. at Tuticorin, and Paumben, (where it was 6 per cent of the main tide,) while at Aden, and Kárwár it is about 5, and 4, per cent respectively.

With regard to the solar diurnal tide (P), the proportion to the main tide is about 25 per cent, similar to what was found in 1877-78, a value which is very much greater than at any other Indian port, except perhaps Beypore, where the proportion is 21 per cent of the main tide.

With regard to the luni-solar declinational tide (K), the same remark applies as in 1877-78, *it being* actually *nine-tenths* of the main tide—a *magnitude* which is *unprecedented.*—

The proportions of the other diurnal tides O, J, and Q to the main tide all agree well with the proportions in 1877-78; that of O is remarkable at Aden, being nearly 50 per cent of the main tide, the usual value at other Indian ports being between 20 and 30 per cent.

The proportion between P and O comes within the limits given by theory; that between J and Q is slightly greater than in 1877-78, and both are much higher than the maximum proportion given by theory. The proportion between O and K is nearly the same as 1877-78, which, although less than the minimum proportion given by theory, agrees well with the proportions obtained at Bombay, and Kárwár.

The overtides of S and M at Aden are all small, and agree well in their proportions to the main tide with what was found in 1877-78.

With regard to the long period tides, the proportions to the main tide (except for the solar annual and solar semi-annual) are much the same as in 1877-78; the solar annual tide being slightly greater, and the semi-annual only half, in proportion to the main tide, to that found in 1877-78.

The solar annual tide at Aden is very great, but is exceeded in value (in proportion to the main tide) at Beypore, and Vizagapatam, at which latter place it actually attains the unprecedented proportion of half the main tide, *thereby exceeding the main solar semi-diurnal tide.*

VALUES OF THE TIDAL CONSTANTS AT KURRACHEE.

Lat. 24° 53′ N., Long. 67° 0′ E.

The observations from which the following tidal constants have been deduced, were taken by the small self-registering tide-gauge working under the supervision of Mr. Price Port Engineer, and have hitherto been unreduced:—

S.

	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
A_1 ...	7·079	7·152	7·153	7·134	7·207	7·331
R_1 ...	0·083	0·076	0·079	0·087	0·088	0·044
ϵ_1 ...	155°·03	152°·50	150°·45	156°·98	180°·35	166°·94
R_2 ...	0·943	0·949	0·953	0·936	0·961	0·922
ϵ_2 ...	321°·19	319°·93	319°·94	318°·09	321°·14	324°·14
R_4 ...	0·010	0·008	0·008	0·012	0·010	0·009
ϵ_4 ...	325°·52	6°·42	353°·25	17°·21	23°·43	29°·43
R_6 ...	0·004	0·007	0·009	0·006	0·005	0·008
ϵ_6 ...	311°·99	308°·53	294°·60	259°·05	274°·57	291°·09
R_8 ...	0·000	0·003	0·002	0·001	0·002	0·001
ϵ_8 ...	26°·57	265°·60	282°·53	206°·57	254°·06	126°·03

M.

R_1 ...	0·083	0·119	0·112	0·022	0·029	0·075
ϵ_1 ...	146°·08	143°·24	72°·80	310°·80	357°·49	312°·63
R_2 ...	2·406	2·434	2·457	2·386	2·391	2·462
ϵ_2 ...	294°·34	292°·79	291°·65	290°·24	290°·29	294°·78
R_3 ...	0·029	0·025	0·035	0·035	0·052	0·046
ϵ_3 ...	332°·61	337°·31	345°·47	342°·39	325°·18	325°·69
R_4 ...	0·021	0·019	0·023	0·018	0·023	0·030
ϵ_4 ...	12°·28	9°·41	15°·25	352°·12	13°·61	358°·59
R_6 ...	0·044	0·051	0·049	0·044	0·018	0·048
ϵ_6 ...	213°·06	214°·44	207°·00	205°·18	192°·88	209°·70
R_8 ...	0·003	0·005	0·005	0·005	0·005	0·004
ϵ_8 ...	160°·78	199°·87	298°·26	279°·15	247°·88	262°·06

K.

R_1 ...	1·379	1·426	1·442	1·403	1·406	1·418
ϵ_1 ...	141°·36	139°·04	136°·34	132°·79	130°·38	131°·39
R_2 ...	0·336	0·317	0·344	0·361	0·331	0·288
ϵ_2 ...	326°·63	322°·93	321°·63	314°·11	305°·12	316°·30

O.

R_1 ...	0·736	0·756	0·767	0·762	0·760	0·763
...	309°·85	311°·79	314°·98	317°·05	320°·65	326°·28

P.

	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
R_1 ...	0·393	0·386	0·367	0·368	0·423	0·440
ϵ_1 ...	318°·07	315°·97	314°·92	316°·97	312°·92	314°·34

J.

R_1 ...	0·067	0·101	0·121	0·090	0·029	0·094
ϵ_1 ...	165°·25	129°·82	141°·36	158°·38	172°·13	147°·07

Q.

R_1 ...	0·136	0·144	0·161	0·146	0·128	0·169
ϵ_1 ...	326°·07	324°·60	315°·08	307°·28	322°·40	324°·12

L

R_2 ...	0·053	0·062	0·051	0·101	0·066	0·037
ϵ_2 ...	89°·08	122°·45	133°·65	113°·06	104°·65	90°·02

N

R_2 ...	0·572	0·542	0·580	0·584	0·539	0·651
ϵ_2 ...	279°·70	277°·38	274°·26	272°·50	271°·44	272°·59

λ

R_2 ...	0·040	0·021	0·009	0·039	0·079	0·062
ϵ_2 ...	81°·01	2°·10	274°·79	119°·73	54°·91	2°·44

μ

R_2 ...	0·052	0·052	0·065	0·063	0·106	0·039
ϵ_2 ...	235°·54	275°·89	260°·16	278°·59	214°·61	293°·68

R

R_2 ...	0·021	0·008	0·069
ϵ_2 ...	328°·79	48°·66	14°·01

T

R_2 ...	0·012	0·122	0·059
ϵ_2 ...	311°·88	62°·99	34°·62

MS

R_4 ...	0·022	0·020	0·030	0·033	0·029	0·032
ϵ_4 ...	308°·67	304°·67	314°·75	312°·98	324°·67	349°·31

28M.

		1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.
R_2	...	0·007	0·017	0·024	0·012	0·025	0·019
ϵ_2	...	126°·94	148°·81	97°·32	115°·18	64°·24	168°·68
				ν			
R_2	...	0·113	0·022	0·148	0·200	0·211	0·124
ϵ_2	...	239°·29	320°·99	316°·97	284°·47	234°·45	209 ·14
				Long period Tides.			
Solar annual	R ...	0·250	0·149	0·086	0·197	0·170	
	ϵ ...	95°·4	56°·3	75°·8	79°·9	119°·6	
Solar semi-annual.	R ...	0·211	0·172	0·173	0·145	0·087	
	ϵ ...	162°·5	156°·6	167°·3	163°·8	69°·7	
Lunar monthly.	R ...	0·050	0·057	0·058	0·085	0·110	
	ϵ ...	55°·8	23°·7	103°·2	42°·1	49°·0	Not yet calculated.
Lunar fortnightly.	R ...	0·016	0·054	0·014	0·046	0·065	
	ϵ ...	237°·4	49°·2	26°·0	356°·2	19°·2	
Luni solar synodic fortnightly.	R ...	0·041	0·039	0·014	0·043	0·037	
	ϵ ...	42°·6	332°·3	185°·4	195°·2	314°·8	

Regarding the values obtained for the short-period tide for Kurrachee 1878-79, the following remarks are applicable:—

The value of (A_0) the mean level of the sea, 7·331, is the highest yet obtained at this place.

The amplitude of the main lunar tide (R_2 of M) is higher than was obtained in the two previous years, but less than any of the values from 1868 to 1872. The value of the main solar tide (R_2 of S) agrees fairly well with that obtained for the four previous years. The value of the main diurnal tide (R_1 of K) is also fairly accordant with the last four years' values.

The proportion between the two main tides R_2 of S, and R_2 of M, (0·375) agrees with the mean proportion obtained from 1868 to 1873, which is less than was found from 1874 to 1878, and this proportion falls short of the equilibrium theoretical value (0·476).

The proportion of the smaller lunar semi-diurnal tide, L, is 0·15 of the main tide, which is much less than was formerly obtained in Kurrachee, and is only about half the theoretical proportion. With regard to the larger component of the lunar semi-diurnal tide N, the reverse is the case, the proportion being 0·265, which is greater than has hitherto obtained at Kurrachee in former years, and in each of the former years the proportion was greater than the theoretical proportion 0·192.

With regard to the lunar perturbation tides λ, ν, and μ, the first agrees fairly with former values, which were about three times the theoretical; the second, ν, also agrees fairly well with former values, viz. about double the theoretical proportion; but the third, μ, is much less than was formerly found, being 0·016 of the main tide for the year 1878-79, the theoretical value being 0·022.

With regard to the solar elliptic semi-diurnal tides R, and T, the former would appear to be excessive in its proportion to the main tide, being 0·028; whereas in all former years the proportion was about ·01 of the main tide, and the theoretical proportion is only ·004. On the other hand, the larger component T agrees well with the theoretical proportion (0·028), while in former years it was almost always too great.

The luni-solar declinational semi-diurnal tide K, agrees fairly well with the theoretical value, as was also the case in former years.

With regard to the diurnal tides, R_1 of S is only about one-half in proportion to the main tide of what was formerly found at Kurrachee; but R_1 of P, R_1 of K, R_1 of O, R_1 of J, and R_1 of Q all agree well with their former proportions to the main tide, while R_1 of M is much greater than in the two preceding years, but is fairly concordant with the proportions obtained previously to those years.

The proportions of the overtides of S and M to their main tides, agree well with those formerly obtained.

With regard to the long period tides, their amplitudes and epochs have not been evaluated, as the daily differences were not considered reliable.

With reference to the long-period tides for 1877-78, the lunar monthly tide has an amplitude about double of that of former years. The solar annual tide is less in amplitude than is usually found at Kurrachee by about 10 per cent, if the value for 1875-76 (which was abnormally small) is neglected. Its epoch, however, is much later than usual, being about the middle of July. The solar-semi-annual tide is only about half as great as obtained in the previous four years; its epoch also differed greatly from that of the previous four years, although it agrees with the value obtained in 1870-71.

VALUES OF THE TIDAL CONSTANTS FOR KARWAR, 1879-80.

Lat. 14° 48′ N., Long. 74° 5′ E.

The following are the amplitudes and epochs evaluated for the

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*R.*	*T.*	*MS.*	2 *SM*
A_0	5·541	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
R_1	0·075	0·025	1·052	0·543	0·274	0·055	0·145	.....	.....	.....	.....	.....	...	...	...	...
ϵ_1	148°·57	277°·06	125°·87	320°·21	312°·73	133°·65	340°·54	.....	.....	.....	.....	.....	...	...	...	...
R_2	0·629	1·709	0·196	.....	.....	.....	.....	0·045	0·420	0·004	0·134	0·055	0·006	0·046	...	0·004
ϵ_2	336°·44	301° 36	312°·80	.....	.....	.....	.....	157°·55	281°·59	306°·16	294° 07	240°·02	161°·20	85° 59	...	355°·31
R_3	.....	0·014	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	..	...	...
ϵ_3	.....	282°·02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	..	...	...
R_4	0·007	0·057	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	0·028	...
ϵ_4	87°·36	15°·15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	73°·51	...
R_6	0·007	0·010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
ϵ_6	87°·53	276°·58	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
R_8	0·002	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...
ϵ_8	295°·40	43°·02	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	...	...	...

Long period Tides.

Lunar monthly	...	$R = 0·058$	$\epsilon = 14°·3$
„ fortnightly	...	$R = 0·070$	$\epsilon = 340°·9$
Luni-solar	...	$R = 0·023$	$\epsilon = 269°·5$
Solar annual	...	$R = 0·344$	$\epsilon = 307°·3$
„ semi-annual	...	$R = 0·083$	$\epsilon = 201°·8$

The value of (A_0) mean level of the sea for 1879-80 is slightly smaller than in the preceding year, being 5·541 feet above zero against 5·650 for 1878-79.

The value of the main lunar tide (R_2 of M) is very slightly greater in amplitude than was found in 1878-79: its epoch agrees almost precisely with that of the previous year.

The value of the main solar tide (R_2 of S) is almost precisely the same as that for 1878-79: its epoch too also agrees well.

The main diurnal tide (luni-solar R_1 of K) is slightly less in amplitude than it was in the preceding year: its epoch, however, agrees well.

The solar elliptic semi-diurnal tides L and N are respectively less and greater in amplitude than what was found in 1878-79, although their epochs agree fairly well with what was found for the previous year.

With regard to the moon's perturbation tides (λ, *ν*, *μ*), there is a considerable difference both in amplitude and epoch for all three from what was found in 1878-79.

The lunar declinational diurnal tide (O) is somewhat less in amplitude, while the solar diurnal declinational tide (P) is somewhat greater than was found in 1878-79.

The elliptic diurnal tides (J and Q) are both greater in value than obtained in 1878-79: their epochs, however, agree well with those of the former year.

With reference to the long period tides for Kárwár for 1879-80, the solar annual tide has an amplitude of 0·34 feet against 0·17 of the previous year, that is, double its value in the

preceding year. The same remark applies to the solar semi-annual tide, which has an amplitude of 0·083 against 0·045 for 1878-79.

The epoch of the solar annual tide occurs about 14 days before the epoch as found from the 1878-79 observations, *i. e.* about the 25th January, while for the former year it was about the 8th February.

The proportions between the two main tides agree fairly well with the proportion for the previous year, and the proportions of the lunar elliptic semi-diurnal tides also agree with those for 1878-79, that of L being precisely the same as the equilibrium theoretical proportion, while that for N is slightly in excess.

The proportion of the evectional semi-diurnal tide (λ) to the main lunar tide, is much less than is given by theory, while that for the other lunar tide (ν) is about double the proportion of that given by theory.

The proportion of the variational semi-diurnal tide agrees fairly well with the equilibrium theoretical value.

Both of the solar elliptic semi-diurnal tides (R and T), are almost exactly the same in proportion to the main lunar tide as the equilibrium theoretical proportion.

The proportion of the luni-solar declinational semi-diurnal tide (R_2 of K) agrees well with the proportion for the former year, which again agreed exactly with the equilibrium theoretical value.

The proportions of the diurnal tides R_1 of S, R_1 of P, R_1 of K, R_1 of O, and R_1 of Q, all agree fairly well with the proportions of the previous year; but the proportion of the diurnal tides (R_1 of M and R_1 of J) are somewhat different, the former being about half and the latter more than double of the proportions found in 1878-79.

The proportion of P to O is slightly different from that in 1878-79, but both the proportions come well within the extreme limits given by theory.

The proportion of J to Q is much greater (0·584) than was found in 1878-79 (0·413), while the maximum proportion given by theory is 0·417.

The proportion of O to K, although exactly the same as that found in 1878-79, is much less than the minimum proportion given by theory (0·657).

The proportions of the overtides of S and M are all small, and agree fairly well with those of the previous year. This remark also applies to the Helmholtz tide (MS), which is 0·012 of the main lunar tide.

The proportion of the long period tides to the main lunar tide call for no special mention, except the solar annual and semi-annual, both of which are twice as great in proportion as was found in 1878-79.

VALUES OF THE TIDAL CONSTANTS FOR BEYPORE, 1878-79.

Lat. 11° 10′ N., Long. 75° 49′ E.

The value of the *mean level of the sea* for the 1878-79 observations was found to be 5·385 feet *above* the zero of the gauge, or 14·323 feet *below* bench-mark A, and 23·076 feet *below* bench-mark C.

The following shows the amplitudes and epochs of the tidal constituents as determined from the 1878-79 observations for Beypore :—

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ	ν	μ	*MS.*	2*SM.*
A_0 ..	5·385	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·021	0·030	0·748	0·372	0·184	0·039	0·086	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	119°·85	27°·20	135°·06	336°·52	318°·93	146°·24	346°·27	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·331	0·892	0·075	.....	.....	.....	.....	0·018	0·188	0·004	0·034	0·023	.....	0·006
ϵ_2 ...	19°·06	328°·32	356°·04	.....	.....	.....	.....	184°·84	304°·03	4°·99	246°·84	197°·73	.....	66°·97
R_3 ..	.....	0·011	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ..	.....	210°·05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ..	0·004	0·021	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·010	.....
ϵ_4 ..	139°·09	41°·48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	74°·31	.....
R_5 ..	0·004	0·009	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_5 ..	252·47	114°·77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8	0·001	0·008	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ..	20°·56	129·06	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar	monthly	tide	...	...	$R = 0{\cdot}069$ $\epsilon = 6^{\circ}{\cdot}0$
„	fortnightly	„	...	...	$R = 0{\cdot}106$ $\epsilon = 355^{\circ}{\cdot}7$
Luni solar	„	„	...	...	$R = 0{\cdot}065$ $\epsilon = 230^{\circ}{\cdot}0$
Solar annual		„	...	...	$R = 0{\cdot}307$ $\epsilon = 311^{\circ}{\cdot}2$
„	semi-annual	„	...	...	$R = 0{\cdot}139$ $\epsilon = 226^{\circ}{\cdot}0$

The proportion between the two main tides (R_2 of M and R_2 of S) is 0·371, which agrees with what was found at Kárwár, but is considerably less than the theoretical proportion.

The small lunar elliptic semi-diurnal tide (L) agrees fairly well in its proportion to the main tide with what obtains at other Indian ports, and is a little less than the theoretical proportion.

The proportion for the larger tide (N) is more nearly accordant with the theoretical porportion than was found at the northern ports of the Bombay Presidency, but is still a little greater than the theoretical proportion, while at the southern ports, Paumben and Tuticorin, the proportion is less than assigned by theory.

The proportions of the moon's perturbation tides (λ, ν, μ) agree well with the theoretical proportions.

The luni-solar declinational semi-diurnal tide is less in proportion to the main tide than has been found for any port in India, and is considerably less than the theoretical proportion, viz. 0·084 to 0·127.

With regard to the diurnal tides, the proportion of R_1 of K is exceedingly high, and approaches closely to what was found at Aden, being 84 per cent of the main tide, which is about double the value at Bombay and Kurrachee.

The proportions of the other diurnal tides R_1 of P, R_1 of M, R_1 of O, R_1 of J, and R_1 of Q are all about 20 per cent (in their proportion to the main tide) greater than obtains at Kárwár, where the proportions again were all greater than at Bombay and Kurrachee.

Thus the whole of the diurnal tides, except R_1 of S, are greater in their proportion to the main tide, than they are at the Indian ports north of Beypore, and approach closely in their proportions to the Aden diurnal tides; but R_1 of S, although agreeing well in its proportion to the Bombay value, is only about half what was found at Kárwár and Aden.

The proportion between the solar and lunar diurnal declinational tides P and O is 0·496, which agrees well with the values at Bombay, Kurrachee, Kárwár, and Aden, and is within the limits of the theoretical values.

The proportion between J and Q is more nearly accordant with the theoretical proportion than at Aden, but is still higher than the theoretical proportion.

The proportion of O to K is much the same as at Bombay, Kurrachee, Aden, and Kárwár, and less than the theoretical minimum proportion.

With regard to the overtides of S, and M, there is nothing very remarkable, except that R_4 of M is slightly greater in its proportion to the main tide than generally happens, being 0·023.

With reference to the long period tides at Beypore, the lunar monthly tide bears a much higher proportion to the main tide than is generally found in Indian ports; this is also true with regard to the lunar fortnightly and luni-solar fortnightly tides, both of which are from three to four times as great in their proportion to the main tide as is usually found.

The solar annual tide also is very large at Beypore, being almost 35 per cent of the main tide, which is very much greater than the proportion at Aden, where it was found to be abnormally high.

The solar semi-annual tide has also a large amplitude at Beypore, being almost double what it is at Karachi, and even greater than at Aden.

It may be remarked, with reference to the long period tides at Beypore and Aden being very large, and also the luni-solar diurnal tide (K) being very great in both places, that the latitude of the two ports is much the same, viz. 12° North.

The complete separation of the main lunar and main solar semi-diurnal tides (M and S), together with their respective epochs, furnishes a ready means of finding the time of spring-tides, or the time at which the two tides are exactly the same in phase.

For instance, the main solar semi-diurnal tide at Beypore attains its maximum when *twice* the mean sun's hour angle from the meridian is 20°·0. Similarly, the main lunar semi-diurnal tide attains its maximum when *twice* the mean moon's hour angle is 328°·3. Dividing the difference between those two epochs by *twice* the difference between their respective daily motions, we obtain an interval at which the two tides are coincident after the time of new or full moon. The difference between the two daily motions is 12°·191: the result for Beypore is 2·12 days, or about 2 days and 3 hours.

VALUES OF TIDAL CONSTANTS FOR PAUMBEN, 1878-79.

Lat. 9° 16′ N., Long. 79° 11′ E.

The following shows the amplitudes and epochs deduced from the 1878-79 observations at Paumben:—

Short period Tides.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ	ν	μ	MS.	2SM.
A_0 ...	2·068	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·036	0·024	0·317	0·127	0·105	0·009	0·023	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	146°·13	263°·69	126°·61	324°·67	313°·73	148°·24	2°·35	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·377	0·578	0·120	.....	.....	.....	.....	0·021	0·075	0·017	0·016	0·004	.....	0·010
ϵ_2 ...	90°·11	44°·70	68°·92	.....	.....	.....	.....	253°·30	27°·25	241°·18	76°·85	73°·92	.....	7°·43
R_3 ...	.....	0·016	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	167°·59	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·005	0·019	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·021	.....
ϵ_4 ...	286°·82	194°·98	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	239°·75	.....
R_6 ...	0·002	0·010	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	245°·56	36°·34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8 ...	0·004	0·005	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ...	245°·59	286°·66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar monthly tide	$R = 0·059$	$\epsilon = 349°·0$
,, fortnightly ,, ...	$R = ·056$	$\epsilon = 343°·4$
Luni-solar ,, ,, ...	$R = ·016$	$\epsilon = 175°·4$
Solar annual ,, ...	$R = ·122$	$\epsilon = 298°·9$
Solar semi-annual ,, ...	$R = ·138$	$\epsilon = 95°·5$

The proportion between the two main tides (R_2 of M and R_2 of S) is 0·652, which is very much greater than the theoretical proportion (0·476), and is the only instance on record, except at Tuticorin, where such a high proportion obtains; at Tuticorin the main solar tide is actually 72 per cent of the main lunar tide.

In one instance only, of all the tidal observations hitherto analysed (viz. at Portland break-water), has the theoretical proportion been exceeded, and the proportions at Paumben and Tuticorin of the solar semi-diurnal tide must be looked upon as abnormally high.

The proportion of the smaller lunar elliptic semi-diurnal tide (L) to the main tide is slightly greater than theory would assign, while that of the greater co-efficient (N) of this tide is considerably less, proportions which are exactly opposite to what obtains at all ports except Tuticorin.

The proportion of the moon's perturbation tide (λ) is high, while that of the other (ν) is low, and the proportion of the variational tide (μ) is also low.

The luni-solar declinational semi-diurnal tide (K) is one-fifth of the main tide at Paumben, which is higher than is usually found, except at Tuticorin, where in fact the whole of the semi-diurnal tides agree well in proportion with Paumben.

With regard to the diurnal tides, there is nothing very remarkable; R_1 of K is perhaps slightly larger than obtains at most places, but is almost the same as was found at Kurrachee and is very much less than obtains at Kárwár, Aden, and Beypore.

R_1 of S is about double in proportion to that at Bombay and Kurrachee, but agrees well with Tuticorin. R_1 of P, approaches closely in its proportion to the mean between Kárwár and Beypore, but is nearly double of what was found at Tuticorin. R_1 of O is much the same in proportion as found in Bombay, which is a good deal less than the proportion obtaining at Kurrachee and Kárwár.

R_1 of Q agrees fairly well with Bombay and Kurrachee in its proportion.

The proportion between P, and O, solar and lunar declinational tides, is very much greater than has been found at any other place: the maximum proportion according to theory is 0·574, while at Paumben it has been found to be 0·832.

The proportion of J to Q has generally been found to be greater than theory would assign, but at Paumben it is actually less, and only at one other port (Tuticorin) has this been found to be the case.

The proportion of O to K is also lower than is generally found.

With regard to the overtides, the only ones of importance appear to be R_3 and R_4 of M, which are respectively 0·028 and 0·033 of the main tide, proportions higher than are usually found.

The long period tides at Paumben give proportions to the main tide higher than are usually found, except for the solar annual, which, although three times as great as at Bombay and Kurrachee, is only half of what obtains at Beypore, and Vizagapatam. But for the solar semi-annual tide the proportion is the largest yet obtained, being 24 per cent of the main tide, and this would point to its being a meteorological tide, due almost entirely to wind, having one maximum in the north-east and one in the south-west monsoon.

It has been often noticed at Paumben that the tidal current through the pass seems to flow entirely in one direction for six months in the year, and in the opposite direction for the other six months: the epoch of this tide occurs about the 6th May and 6th November. The epoch of the solar annual tide at Paumben occurs about the 14th January, which is about the middle of the north-east monsoons.

VALUES OF THE TIDAL CONSTANTS FOR VIZAGAPATAM, 1879-80.

Lat. 17° 41′ N., Long. 83° 17′ E.

The value of the *mean level of the sea* from the year's observations was found to be 4·991 feet *above* the zero of the gauge, or 13·968 *below* bench-mark C.

The following shows the amplitudes and epochs deduced from the 1879-80 observations at Vizagapatam:—

Short period Tides.

	S.	*M.*	*K.*	*O.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*ν.*	*μ.*	*MS.*	2 *SM.*
A_0 ...	4·991	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_1 ...	0·023	0·036	0·393	0·152	0·112	0·038	0·011	.....	.....	.....	.....	.....	.....	.....
ϵ_1 ...	100°·62	239°·02	60°·65	249°·60	245°·86	47°·32	299°·21	.....	.....	.....	.....	.....	.....	.....
R_2 ...	0·074	1·569	0·203	.....	.....	.....	.....	0·053	0·350	0·021	0·112	0·029	.....	0·008
ϵ_2 ...	286°·15	246°·61	254°·24	.....	.....	.....	.....	90°·48	241°·17	18°·65	241°·63	236°·10	.....	211°·64
R_3 ...	.....	0·007	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3 ...	.....	329°·25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4 ...	0·001	0·014	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0·007	.....
ϵ_4 ...	350°·93	306°·38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	343°·14	.....
R_6 ...	0·001	0·003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_6 ...	123°·69	187°·86	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_8 ...	0·001	0·004	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_8 ...	72°·00	165°·84	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long period Tides.

Lunar monthly tide ...	...	$R = 0·021$	$\epsilon = 22°·5$
,, fortnightly ,, ...	...	$R = 0·036$	$\epsilon = 3°·1$
Luni-solar ,, ,, ...	...	$R = 0·075$	$\epsilon = 24°·2$
Solar annual ,, ...	...	$R = 0·740$	$\epsilon = 190°·1$
,, semi-annual ,, ...	...	$R = 0·301$	$\epsilon = 88°·6$

The proportion between the two main tides (R_2 of M and R_2 of S) agrees fairly well with the theoretical value. The proportions between the two lunar elliptic tides, although agreeing well *inter se*, are slightly larger than the theoretical proportion.

The moon's perturbation tides (λ and *ν*) are each double the theoretical proportion, but for *μ* the proportion is slightly less.

The luni-solar declinational semi-diurnal tide (K) agrees well in its proportion with the theoretical value; this has usually been found to be the case at other ports.

One of the main features of the tides at Vizagapatam is, that the diurnal tides are very small in proportion to the main lunar tide, being almost in every case about one-half what obtains at Kurrachee and Bombay.

The smallness of the main diurnal tide (R_1 of K) is remarkable, being only 26 per cent of the main tide, which is the least proportion yet obtained in India, with the exception of Hanstal at the head of the Gulf of Cutch.

Vizagapatam being the first station in the Bay of Bengal where observations have been deduced, it would be interesting hereafter to see if this feature, viz. the smallness of the diurnal tides, obtains at other ports in the Bay.

The proportion between P and O is much larger than the theoretical maximum proportion, and in this it approaches more nearly to what was found at Paumben than at any other port.

The proportion between J and Q is most remarkable. Theory would assign a value of about 0·4, that is to say, Q would be about two and a half times as great as J; but at Vizagapatam J is actually about three and a half times greater than Q.

The proportion between O and K is a little less than was found at other places.

The overtides of S and M are all small, and call for no special mention. *But the most remarkable feature of the Vizagapatam tides* is the exceedingly high proportion of the solar annual tide, which is almost half the magnitude of the main lunar tide: this is about double what was found at Aden, where it was first noticed to be abnormally high. The solar semi-annual tide also is very large, although not quite so great as at Paumben.

The epoch of the solar annual tide occurs about the end of September; the epoch for the semi-annual tide occurs about the beginning of May, and beginning of November, dates which agree well with what was found at Paumben; which is still further evidence of this tide being mainly due to wind.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Statement showing the nature of the work performed, and the progress made, from 1st *October* 1879 *to* 30*th September* 1880.

Maps.	Scale. In. Miles.	Remarks and Progress.
India; 6 sheets, outline and names	1 = 32	Fresh additions and revisions from recent surveys to date, made on dry print proofs of sheets I, III, IV, and VI, for insertion on copper-plates.
India, No. 3; 2 sheets, outline and names.	1 = 64	Revision of new transfer proofs to date, and completion of all unsurveyed blanks, for a *second* edition in outline. In progress.
India; 1 sheet, outline	1 = 96	Reduction of above. Provincial and other boundaries, railway lines, territorial and other principal names, completed and inserted on a dry print proof of outline for engraving.
India, No. 3; 4 sheets, outline and names.	1 = 64	Fresh additions and revisions from recent surveys to date made on dry print proofs, for insertion on copper-plates.
Bengal; 2 sheets, outline and names.	1 = 16	Plate transfer proofs, in outline examined, revised, and completed for a new edition. Hill drawing, on dry print proofs from the plates, in progress.
Punjab; 4 sheets, outline and names.	1 = 16	New compilation, to embrace all recent surveys to date. Drawing and compilation in progress. To be engraved.
Central Provinces; 2 sheets, outline and names.	1 = 16	Hill drawing on mounted silver prints of the original compilation in outline completed for engraving.
Central India Agency; 2 sheets, outline and names.	1 = 16	Fresh additions made on dry print proofs from plates, from recent surveys to date. Hill drawing on mounted silver prints of the original compilations in outline, in progress for engraving.
Rajputana Agency; 2 sheets, outline and names.	1 = 16	
Berar. (Hyderabad Assigned Districts), 1 sheet.	1 = 8	New compilation. Drawing in progress.
Southern Afghanistan; 4 sheets ...	1 = 4	Compilation and drawing in outline, embodying all the recent surveys to date. In progress.
Northern Afghanistan	1 = 32	Compilation and drawing complete with hills, embracing all recent surveys; for embodyment in sheet 2, fifth edition, map of Turkestan.
Seat of war, Northern Afghanistan; 4 sheets; country between lat. $\frac{33°\,0'}{35\,45}$ N. and long. $\frac{68\,0'}{71\,30}$ E	1 = 4	General compilation. Additions from recent surveys and various fresh materials to date, made and drawn complete with hills. Blue prints of same, redrawing in progress.
Route map, Punjab, Cashmere, and Western Himalayas.	1 = 32	Compilation and drawing on west, with revisions to date, on a dry print proof from plate. In progress.
Country round Kabul	1 = 1	Sheet II. Tracing on vellum cloth from a rough original.
District Maps.		
Farukhabad	1 = 8	Drawn for the *Gazetteer*, North-Western Provinces.
Bahraich	1 = 4	The new boundary between Bahraich and Nepal inserted on a proof for a new edition.
Backergunge	1 = 4	Extracted from the sheets of the Atlas of India, and prepared and completed to date for publication.
Noakholly	1 = 4	
Sylhet	1 = 4	
Cachar	1 = 4	
Dacca	1 = 4	
Mymensingh	1 = 4	
Furreedpore	1 = 4	
Rungpore	1 = 4	
Hazaribagh	1 = 4	
Index Maps.		
Assam, 8-mile sheets	1 = 64	An index to the 8-mile sheets drawn.
Index to the sheets of the Atlas of India.	1 = 96	Revisions to date made on a dry print.
India, showing imperial surveys in progress to 1st October 1880.	1 = 128	Prepared for report, 1879-80.
Atlas of India, showing state of engraving and publication to 1st October 1880.	1 = 256	
Surveys of India (Topographical) showing the sheets published.	1 = 32	

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Sheets of the Atlas of India, 1 inch = 4 miles.

12, S.E.	Part of Kattywar	Further additions drawn with hills, to complete sheet on the west.
18, N.W. S.E.	Parts of Bahawalpur and Bickaneer Native State.	Additions on north-west corner drawn to complete. Additions drawn in outline to extent of survey.
31, N.W.* S.W.* N.E.* S.E.*	Parts of Montgomery, Ferozepore, Sirsa, and Hissar districts, and Patiala, Bahawalpur and Bickaneer.	Bahawalpur portion drawn complete; additions from recent surveys in progress.
32, N.E. S.E.	Parts of Bickaneer, Shaikawati, and Hissar.	Additions drawn on west to complete.
33, N.W. S.W.	Parts of Jodhpore and Bickaneer.	Further additions drawn on west to complete.
35, N.W.	Part of Oodeypore	Additions on west drawn in outline to complete.
36, N.W.* S.W. N.E. S.E.	Parts of Guzerat and Central India Agency.	Drawn in outline to extent of survey. Additions drawn in outline to extent of survey.
37, N.E.	Parts of Khandesh, &c. ...	Additions drawn complete with hills.
38, N.W.* N.E.* S.E.*	Parts of Nasik and Ahmednagar districts and Hyderabad.	Drawing in outline in progress.
48, N.E.	Parts of Bijnor, Dehra Dun, &c.	Drawing in outline in progress.
53, S.W.	Part of Central India Agency	Further additions drawn complete with hills.
60, N.E.*	Part of Mysore	Drawing in outline in progress.
66, N.E. S.W. S.E.	Parts of Bijnor, Kumaun and Garhwal.	Hills drawn complete with additional outline and names.
67, N.W.* N.E.* S.W.* S.E.*	Parts of Tarai, Kumaun, Moradabad, Budaun, and Bareilly districts.	Drawing in outline completed of 67 S. E. and drawing of the other three quarters in progress.
69, S.E.	Parts of Hamirpur and Banda districts.	Drawing in outline of additions on north to complete. In progress.
118, F. P.	Parts of Jalpaiguri, Cooch Behar, Bhutan, &c.	Revision of south-eastern portion of sheet (Goalpara) completed in outline from recent survey.
119, F. P.	Parts of Rungpore, Maldah, Dinagepore, Mymensingh, &c.	Revision of Goalpara district, on the north-east of sheet, completed with Hills.

* The 13 quarters marked* are new sheets.

Standard Sheets of the Topographical Survey drawn for reproduction.

	Scale. In. Miles.	
Ganjam and Orissa Survey.		
Sheets $\frac{88, 89, 90, 91}{\text{in one}}$	1 = 2	Fair drawn complete with hills from the original field sheets.
Hyderabad Survey in 18 sheets.		
Sheets 1, 2, 3, 4, 6, 7, 11, 12, 14, 16, 17, 18.	1 = 1	Fair drawn complete with hills from the original field sheets.
Sheets 5, 8, $\frac{9 \text{ and } 10}{\text{in one}}$, 13, 15 ...	1 = 1	Fair drawn in outline from the original field sheets. Hills in progress.
Central Provinces Survey.		
Sheets 14, 15, and 9	1 = 1	Fair drawn complete with hills from the original field sheets.
Khasi, Garo, and Naga Hills Survey.		
Sheets 13, 23, 27, and 28, originals	1 = 2	Unsurveyed blanks in the original sheets filled in from recent surveys. for a 2nd edition.
Simla and Kalka Road Survey.		
Sheet 5 D.	6 = 1	Fair drawn from the original field sheet.
Thal Chotiali Route Survey.		
Sheet 1	1 = 4	Compiled and drawn complete with hills from the original field sheets.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Miscellaneous Maps, Tracings, &c.

	SCALE. In. Miles.	
Soolay Pagoda and town of Rangoon.	.....	Exhibits A, B, C, and D. Four sections drawn on vellum cloth from originals.
Zaimukht valley and country adjoining British territory.	.....	Drawn on vellum cloth for reproduction and issue.
Gunja Tract	1 = 1	Drawn on vellum cloth for Secretary to the Board of Revenue, Lower Provinces.
Murree and Kahuta Tahsils ...	4 = 1	Tracing made on vellum cloth showing progress of survey to 1st January 1880.
Mullah's Explorations in 1878 ...	1 = 8	Sketch to illustrate. Drawn for the General Report of 1878-79.
Country between Pishin and Shorawak.	1 = 4	Traced on vellum cloth from the original sheets, and drawn for reproduction.
Triangulation Chart, Kandahar, minor series, 1879.	1 = 4	Tracing made on vellum cloth.
Route of mission from Kandahar to Herat in June and July 1839.	1 = 4	Tracing made on vellum cloth.
Country between Karez-i-ata and Panjwai, Southern Afghanistan.	1 = 1	Fair drawn for reproduction from the original plane table sections.
Route Survey in 4 sections from Madadalari station to Lehri, by Captain Beavan.	1 = 1	Fair drawn for reproduction from the original plane table sections.
Jellalabad district, Afghanistan, with the Kunar and Laghman valleys, showing tribal divisions.	1 = 2	Drawn from various materials complete with hills. To be lithographed for the Punjab Government.
Boundary between district Bahraich of Oudh, and Nepal, along the Rapti river, from pillar 13 to pillar 20.	1 = 4	Fair drawing made for Resident, Nepal, from an original supplied.
Reconnaisance Survey, part of N. E. Beluchistan, by Captain Maitland.	1 = 4	Traced and drawn complete with hills from the original sheets, for reproduction.
India, Frontier Trade Map ...	1 = 96	A dry print from the plate of India 96 miles, completed in outline to illustrate "Report on the Frontier Trade of India," for the Government of India. Hills in progress.

548 sheets of various engraved, lithographed, and photozincographed proofs, examined, corrected, and added to for publication in a complete form.

J. F. BANESS,
Surveyor and Chief Draftsman.

JOHN O. N. JAMES,
Assistant Surveyor-General.

Work done by the Examining Branch from 1st October 1879 to 30th September 1880.

Subjects examined ...	Original standard sheets of topographical surveys and standard sheets compiled in Surveyor-General's Office, as also large scale plans and triangulation charts of the various topographical survey parties ...	40 sheets.
	Original compilations of parts of atlas sheets and other maps compiled in Surveyor-General's Office	27 do.
	Engraved proofs in outline, names, &c., in various stages, and general and provincial maps	254 do.
	Photographed and lithographed proofs of various scales, including maps, plans, atlas sheets, &c. (examination and additions of new territorial boundaries, &c.)	
Hill shading in brush of atlas sheets, 22 N. W.; 129 S. W. and S. E.; 130 S. E.; 138 N. W. and S. W., and 45, pen-work horizontal shadings of two standard sheets, Nos. 13 and 15, Central Provinces Topographical Survey, and scraps of other maps of the North-West Frontier		9 do.
Work compiled	Standard sheets Nos. 13, 14, and 15, Central Provinces Topographical Survey, part of atlas sheet 37 N. E., and assisted in the compilation of the 1st edition, seat of war map (Afghanistan), and also subsequent editions	5 sheets & scraps.
Projection of compilation maps and atlas sheets, the latter marked on copper-plates by this section for the engravers		21 sheets.
Miscellaneous work ...	Supply of numerical data (latitudes, longitudes, and heights) to various district officers, also areas of districts, &c.	
	Computation of atlas graticule.	
	Calculation of revenue survey coordinates into latitudes and longitudes.	
	Reports, memoranda, &c.	

A. CHAMARETT,
Surveyor, Sec. II., Examining Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1879 TO THE 30TH SEPTEMBER 1880.

General Maps, &c.

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Map of India, 32 miles=1 inch—			
Sheet 1	51 W.	.....	Additional outline and writing completed.
,, 3	275 O. W.	.....	Heavy additions and corrections to outline and writing nearly done.
,, 4	146 W.	.....	Corrections and heavy additions to writing, in progress.
Map of India in 4 sheets, scale 64 miles=1 inch.	378 W.	.....	Corrections and heavy additions to writing, completed to the four sheets.
Map of India, scale 96 miles=1 inch.	196 W.	.....	Alterations to suit authorized spelling of names. As far as drawing, completed. Plate put down.
Map of Bengal in 2 sheets, scale 16 miles=1 inch.	131 W.	.....	Corrections and heavy additions to writing nearly completed. In progress.
Map of Central Provinces in 2 sheets, scale 16 miles = 1 inch.	607 O. W.	.....	Outline completed. Writing more than half done. In progress.
Map of Rajputana in 2 sheets, scale 16 miles=1 inch.	234 O. W.	.....	Corrections to outline done. Writing completed. Plates put down, waiting for fresh materials.
Map of Central India Agency in 2 sheets, scale 16 miles=1 inch.	385 O. W.	.....	Additional outline done. Writing nearly completed. In progress.
Map of Assam, scale 16 miles=1 inch.	20 O. W.	.....	Corrections of outline and additional writing completed.
Map of Himalaya Routes, scale 16 miles=1 inch	206 W.	.....	Writing well advanced. In progress.
Plan of Calcutta	.....	.....	Corrections and alterations done.
Chart of Colombo Harbour (for the Marine Survey Department).	.....	.....	Additional cultivation and jungle completed. Plate finished.
Chart of the Indian Ocean ...	50 O.	.....	Border projections and magnetic variation curves completed. Outline just commenced.
Scale plate, 5,280 feet to the inch.	.....	.....	Repaired and figures cut. Plate finished.
Scale clinometer	.....	.....	Engraved and finished.
Idiometer machine	.....	.....	Well advanced. In progress.
Scale vernier	.....	.....	Engraved and finished.
Imprint plates	.....	.....	Alteration of dates done.
Map headings for Topographical Surveys.	.....	.....	Repaired and finished.
Map heading, Hyderabad Topographical Survey.	.....	.....	Engraved, and transfer sent to press.

INDIAN ATLAS SHEETS (*New*) *completed and published.*

NOTE.—The progress during the year is shown in square inches. A full sheet of the Atlas contains 927·2 square inches; quarter plate 231·8 square inches.

Atlas sheets—			
18 S. W.	.....	134 sand	Complete up to margins.
18 N. W.	6 W.	80 ,,	
22 S. W.	.....	80 hills	
37 N. E.	160 W.	120 ,,	
53 S. W.	.....	135 ,,	
91 N. W.	.....	59 ,,	
92 N. W.	.....	168 ,,	
92 S. W.	.....	46 ,,	Completed up to limits of survey.
129 N. E.	.....	12 ,,	
129 N. W.	8 W.	49 ,,	
129 S. W.	.....	116 ,,	
130 N. E.	.....	96 ,,	

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1879 TO THE 30TH SEPTEMBER 1880.

INDIAN ATLAS SHEETS (*New*) *in progress.*

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Atlas sheets—			
12 S. E.	12 W.	.....	A small portion of fresh outline done. Writing nearly completed. In progress.
13 N. E.	.....	.....	Slight additions.
19 N. E.	3 W.	3 sand	Small portion of outline and writing completed. Sand-hills, $\frac{1}{8}$ of the drawing done. Plate put down for more urgent work.
22 N. E.	6 W.	.....	Writing as far as drawing completed.
22 N. W.	.....	3 hills	Hills and jungle completed as far as drawing.
22 S. E.	.....	.....	Heavy portion of river water-line and jungles completed as far as drawing.
31 N. W.	.....	.....	Border and projections completed. Outline just commenced.
31 S. E.	... ...	.....	Ditto ditto.
32 S. W.	20 O. W.	59 sand	Outline and writing completed as far as drawing. Sand-hills nearly finished.
33 N. W.	16 O. W.	30 „	Heavy portion of fresh work up to margin. Outline and writing completed. Sand-hills half done. In progress.
33 S W.	30 O. W.	.....	Writing completed as far as drawing; the remaining portion up to margin, outline done. Writing just commenced.
35 N. W.	49 O. W.	.....	Outline completed as far as drawing. Writing and figures $\frac{3}{4}$ done. In progress.
35 S. W.	35 O. W.	.....	Outline and writing completed as far as drawing.
36 N. E.	40 O. W.	.....	Heavy portion of fresh outline completed. Writing $\frac{1}{4}$ done. In progress.
36 S. E.	50 O. W.	.....	Small portion of fresh outline and writing completed.
36 S. W.	52 O. W.	.....	Outline and writing completed as far as drawing.
53 N. W.	40 O. W.	.....	Outline completed up to margin. Writing $\frac{1}{8}$ done. In progress.
66 N. E.	10 W.	92 hills	Corrections and two tablets on the margin completed. Hills in progress.
66 S. E	25 W.	25 „	Corrections and two tablets on the margin completed. Hills just commenced.
66 S. W.	30 W.	.....	Two tablets on the margin done, with heavy addition.
67 S. E.	.....	.....	Outline just commenced.
77 N. E	190 O. W.	.....	Outline completed. Writing more than half done. In progress.
86 S. E.	.....	2 hills	Hills completed as far as drawing.
129 S. E.	116 O. W.	.....	Outline completed up to margin. Writing $\frac{1}{2}$ done. In progress.
130 S. E.	23 O. W.	.....	Heavy portion of fresh outline and writing completed.
138 N. W.	.....	10 hills	Writing completed as far as drawing. Hills almost half done. In progress.
138 S. W.	21 W.	.....	Writing completed as far as drawing.

Additions and Corrections to Indian Atlas Sheets.

8 S. E.	65 W.	.....	Heavy portion of fresh work. Writing nearly completed.
23 N. W.	.....	.....	Slight additions.
32 S. E.	20 W.	65 sand	Heavy portion of fresh work. Writing and sand-hills done. Plate finished.
66 N. W.	12 W.	.....	A tablet on the margin engraved and heavy additions to the plate.
71 N. E.	.....	49 hills	Jungle and hills of new survey completed.
72 N. E.	.....	.....	Slight corrections and additions to hills done.
54	.....	185 hills	Heavy addition. Repairing hills and jungles completed.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1879 TO THE 30TH SEPTEMBER 1880.

Additions and Corrections to Indian Atlas Sheets—concluded.

Title of map.	Outline and writing.	Hills and sand-hills.	Remarks showing progress.
	Sq. In.	Sq. In.	
Atlas sheets—			
62	.....	.....	Small portion of railway and station names engraved.
63	.....	.....	Corrections to outline done. A few additional station names engraved.
65	50 W.	12 hills	Portion of new survey. Writing done. Hills ¼ done. In progress.
79	.....	.. ...	Small portion of railway and a few station names engraved.
80	.....	.....	Corrections to outline done. Some additional station names engraved.
81	.....	.....	Ditto ditto.
102	300 O. W.	.....	Additions and corrections to outline done. Writing recut. Completed.
103	.....	.....	Small portion of railway engraved.
104	.....	.....	Ditto ditto.
118	38 O. W.	.....	Heavy additions. Outline and sand-bank completed. Writing ¼ done. In progress.
119	.....	.....	Slight corrections and additions.
121	.....	.....	Corrections done.
	4,106	1,630	Grand total of square inches of new work on all the plates.
Repairing of old Full Indian Atlas sheets.			
38	.....	106 hills.	Repairing hills almost ½ done. In progress.
41	.....	302 ,,	Heavy sheet. Repairing hills completed.
49	.....	12 ,,	Small portion of hills repaired. Completed.
55	.....	509 ,,	Heavy sheet. Repairing hills completed.
73	300 W.	.....	Writing repaired. Completed.
106	.....	292 ,,	Heavy sheet. Repairing hills ¾ done. In progress.
115	.....	90 ,,	Heavy sheet. Repairing hills completed.
116	.....	25 ,,	Hills repaired. Completed.
120	431 W.	.....	Heavy sheet of writing recut. Nearly completed.
	731	1,336	Total square inches of repairs.

Miscellaneous work, viz. notes and references on plates, borders, &c.

8 Plates.—Outside names and figures completed; 37 N. W.; all four quarters of 48, 67 N.E., 67 N.W., 67 S.W.

8 Ditto.—Slight corrections and additions have been made to atlas sheets 51 S.E., 51 S.W., 51 N.E., 86 S.W., 87 N W., 90 S.W., 124 S.W., and 130 N.W.

20 Ditto.—Outside names and figures in progress—31 N.E., 31 S.W., three quarters of 134 and 135, all four quarters of 59, 145, and 146.

12 Ditto.—Outside names and figures completed—all four quarters of 38, 39, and 49.

Number of plates in hand during the year, 145.

Copper plate Printing.

Proofs	894
Transfers	414
Impressions	4,375
Total ...	5,683

Steel-facing completed.

The preparation for steel-facing copper plates was commenced on the 3rd December 1879. The first trial plate was steel-faced, and approved by the Surveyor-General on the 7th January 1880, from which date up to the 30th September 1880 the following atlas sheets and miscellaneous plates have been steel-faced. Indian atlas sheets 29, 39, 41, 42, 47, 50, 58, 60, 61, 62, 63, 73, 74, 75, 79, 102, 114, 3 N.E., 10 S.W., 18 S.W., 18 N.W., 22 S.W., 23 N.W., 34 S.W., 35 N.E., 51 S.E., 51 S.W., 69 N.E., 70 S.W., 71 N.E., 90 N.E., 90 S.E., 90 S.W., 91 N.W., 91 S.W., 124 N.E., 130 N.E., 130 N.W., 130 S.W. Colombo Harbour chart, large tint plate B, and one small scale of shade plate.

Full sheets steel-faced	17
Quarter ,, ,, ...	22
Miscellaneous ,, ...	3
Total ...	42

C. W. COARD,
Superintendent, Engraving Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General.

Table A.

Tabulated Statement of the principal Records prepared in the several Executive Offices of the Revenue Branch, for the year ending 30th September 1880.

Province.	Survey party.	District.	Cadastral: Sheets.	Cadastral: Amin's field sketch-books.	Cadastral: Field area statements.	Atlas sheets 4″ = 1 mile.	Quarter sheets 2″ = 1 mile, or standard 1″ maps.	Triangulation charts and index maps.	Area traverses: Main circuit with azimuth computation.	Area traverses: Village or sub-circuit.	Field-books: Main circuit.	Field-books: Village or sub-circuit.	Original field plans.	For Settlement Department: Traces of sheets.	For Settlement Department: Khasra field area statements.
			No.	Vols.	Villages.	No.	No.	No.	Vols.	Vols.	Vols.	Vols.	No.	No.	Villages.
								CADASTRAL SURVEYS.							
N.-W. Provinces...	No. 4	Ghazipur	16″ scale 861	.....	1,524	.....	10 partially ...	1 Index map ...	1	3	1	6	*Vide* sheets	111	1,524½
	,, 5	Banda	1,117(*a*)	173(*a*)	1,209(*a*)	149(*a*)	.....	.....	.....	.....	.....	.....	.....	20	4
	,, 6	Mirzapur	692	.....	805	.....	6 not commenced	1 Index map ...	2	4	2	12	*Vide* sheets	55	723
		Jaunpur	1,087	.....	1,371	11	16 partially ...	1 Ditto ...	4	3	4	18	Ditto	.....	1,371
Bengal	,, 7	Poorce	32″ scale 3,362(*a*)	129(*a*)	23	46 complete 18 skeleton	.....	1 Ditto ...	3	10	4	24	13 on 4″ 45 on 4″ 2 vols. ordl. bd. plans.	3,362 on 32″ 1,051 skeleton. 26½ ditto	941
British Burma ...	,, 8	Bassein	16″ scale 471	.....	179	.....	7 not commenced	1 Ditto ...	1	1	1	2	*Vide* sheets	188	188
	,, 2	Hanthawaddy ...	1,105	.....	279	.....	11 partially ...	1 Ditto ...	2	6	2	5	Ditto	319	294
			Horizontal and vertical angle-books.	Triangle computation.	Computation of heights.			VILLAGE AND TOPOGRAPHICAL SURVEYS.							Areas of villages.
			Vols.	Vols.	Vols.										
Punjab	No. 1	Dera Ismail Khan ...	.....	.....	.....	50 (size 400 × 500). Chs.	.....	1 Index map ...	1	1	1	1	*Vide* sheets	34 Trace maps	71
		Rawalpindi	.....	.....	.....	45 (size 71′ × 34′).	.....	1 Ditto ...	.....	.....	.....	.....	45 on 4″ ...	45 Blue prints for Forest Department.	.....
N.-W. Provinces...	,, 3	Saharanpur	.....	.....	.....	3 of Patri forest. 4 on 6″ city & civil station.	.....	.....	1		1	15	3 on 4″ Patri forest. 4 on 6″ city and civil station. 180 on 2″ (320 × 240 Chs.)	.....	.....
		Muzaffarnagar ...	.....	.....	.....	.....	43 on 2″ scale for reproduction.	1 Ditto ...	1	5	1	17	20 on 2″ (5′ × 3½′).	.....	.....
		Meerut	.....	.....	.....	.....	47 on 2″ scale for reduction.	1 Ditto ...	1	1	1	6	33 on 2″ do.	.....	.....
		Jumna River Survey	.....	.....	.....	38 (size 400 × 500). Chs.	.....	.....	.....	.....	.....	.....	*Vide* Atlas sheets.	.....	.....
	,, 4	Budaun	.....	.....	.....	9 (size 400 × 500).	.....	.....	.....	.....	.....	.....	Ditto ...	6 on 4″	.....
Bombay	,, 10	Poona, Ahmednagar, Tanna and Colaba.	4	1	1	.....	32 on 2″ ...	1 Atlas reduction ½″ 2 Traverse index maps. 1 Triangulation chart	1	2	1	2	52 on 2″ ...	18 skeleton plots.	Copies of all traverse data.(*b*)
	,, 11	Sholapur, Ratnagiri, Satara and Colaba.	2	2	1	.....	24 on 2″ ...	2 Index maps 2 Triangulation charts.	3 Main and sub-traverse.		4 Main and sub-traverse.		26 on 2″ ...	.....	Ditto.

(*a*) Includes work of previous seasons.

(*b*) Also 1 volume of rectangular co-ordinates.

Deputy Surveyor-General's Office;
Calcutta, 1*st October* 1880.

F. Coddington, *Major*,
Deputy Superintendent at Head-Quarters

Table B.

Statemnt of Work performed in the Drawing and Compiling Branch of the Deputy Surveyor-General's Office during the 9 months extending from 1st January to 30th September 1880.

Title of Map.	Scale.	Remarks.
	Inch. Mile.	
Punjab.		
Districts Bannu and Dera Ismail Khan in 41 sheets, standard size, 30′ × 15′	1 = 1	Graticule lines have been inserted on 122 original 4″=1 mile sheets, comprising sheets Nos. 2, 3, 6, 7, 10, 14 and 15, and sent to press for photo. reduction to half scale.
Number of sheets published to date, 5.		The 2″ blue prints received from press of sheets 1, 4, 5, 6, 7, 8, 9, 11, 12, 13, 16, 17, 20, 21 and 25, have been typed and re-drawn in black for reduction to 1″ scale, and all examined, except sheets 6, 7, 11, 13, and 16. Sheets 24, 25, 28, 29 and 32 (drawn last year) have been examined. The following 2″ sheets (blue prints) have been re-drawn and sent to press for reduction and publication on 1″ scale, viz. Nos. 1, 4, 8, 12, 20, 24, 28, 29, and 32, of which sheets 1, 4, 8, 12 and 24, have been published to date.
Districts Bannu and Shahpur, Sakesar Sanitarium, in 2 sheets ...	16 = 1	The original plan, drawn in the Executive's office, was examined, lines of longitude and latitude inserted, and sheets completed for photo. re-production to scale. Publication has been completed.
District Sirsa, in 16 sheets, standard size, 30 × 15′	1 = 1	The original 1″ sheets prepared in the Executive's office were examined with 4″ village sheets, corrected, completed and made suitable for photo. re-production, and sent to press. Publication has been completed.
District Ssa, preliminary district map and sheet index ...	¼ = 1	Drawn, examined, and sent to press for publication by photography. Publication has been completed.
North-Western Provinces.		
District Muttra, in 7 sheets, standard size, 30′ × 15′	1 = 1	The five 2″ sheets drawn last season have been examined, and the remaining two have been drawn, examined, and sent to press for photo. reduction. Publication has been completed.
District Moradabad, in 13 sheets, standard size, 30′ × 15′ ...	1 = 1	The 2″ blue prints of sheets 30, 46, 63 and 64, have been re-drawn in black, but await additions from the adjoining districts Bijnor and Tarai to complete them to margin. No sheets yet published.
District Budaun, in 11 sheets, standard size, 30′ × 15′ ...	1 = 1	Graticule lines inserted on 51 of the 4″=1 mile maps, comprising 6 standard sheets Nos. 33, 34, 51, 52, 53 and 67, sent to press for photo. reduction to 2″ scale previous to being re-drawn in black for final reduction to 1″. None yet published.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
	Inch. Mile.	
Oudh (new edition) in 65 sheets, standard size, 30′ × 15′ ...	1 = 1	The original maps, with graticule lines inserted, comprising sheets 100, 120, 129, 130, 144, 146 and 147, sent to press for lithography. One sheet, No. 144, has been published.
Bengal.		
District Midnapore, in 18 sheets, standard size, 30′ × 15′ ...	1 = 1	The 2″ sheets 2, 3, 6, 9, 12, 13, 15, 16 and 18, drawn last year have been examined, corrected and completed for press; sheet No. 5 completed up to margin by addition from Bankoora district; sheets 1, 4, 7 and 10, drawn in Executive's office, have been examined and completed for press; 2″ sheet 14 has been drawn. Portion of district Balasore is being added, which will complete 3 sheets up to margin. All but sheets 8, 11, 14 and 17 have been published.
District Noakholly, in 12 sheets, standard size, 30′ × 15′ ...	1 = 1	Graticule inserted on original 1″ maps, and skeleton standards 30′ × 15′ prepared for guidance of Litho. press. No proofs received to date.
Bombay.		
Deccan Topographical Survey, 2″=1 mile, between latitude 17° and 20°-45′ including the Konkan, in 96 sheets, standard size, 30′ × 15′ ...	1 = 1	Since the last report, 2″ standard sheets Nos. 26, 27, 28, 32, 49 and 53, drawn in Executives' offices, have been examined and completed for publication and sent to press; of which sheets 49 and 53 have been published.
Number of sheets published to date, 50.		
Index Maps.		
Of districts Dera Ismail Khan and Bannu; Rawalpindi; Saharanpur; Muzaffarnagar; Meerut; Ghazipur; Ballia; Banda; Mirzapur; Jaunpur; Cuttack and Pooree; Hanthawaddy; Bassein; Deccan and Konkan	On various scales.	Brought up to date and re-published to illustrate the Annual Report of 1879-80. The Bassein index was re-typed, and hill portion re-drawn in head office.
Miscellaneous Traces, &c.		
Traces of 9 atlas sheets of Gangés Deara Survey of 1865-66, showing in red the positions of village boundaries as surveyed in 1842-46	4 = 1	For Collector of Patna.
Traces of 6 villages of district Patna	4 = 1	For do. do.
Trace of Dalleseri River, 1858-63 (3 sections)	4 = 1	For Commr. Dacca Div.
Traces of 3 atlas sheets of district Hooghly	4 = 1	For Govt. of Bengal.
Traces of 5 atlas sheets of district Pilibhit	4 = 1	For Collector.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
Miscellaneous Traces, &c.—continued.	Inch. Mile.	
Traces of 4 atlas sheets of district Karnal, showing Jumna River and adjoining villages ...	4 = 1	For Deputy Supdt., No. 3 Party.
Map of portion of Bannu district ...	4 = 1	For Geological Survey.
La and Nisfi khiraj estates surveyed 1878-79, inserted on the original 4″ congregated village sheets, district Kamrup	4 = 1	For office record.
Inserted on a set of printed maps of Sindh the co-ordinate data, traverse stations, and lines and series of triangles, along the Runn of Cutch	1 = 1	For Surveyor-General.
Overlaps for Deccan sheets of 1879-80	2 = 1	For Executives.
Specimen map for reduction to 1″ scale	2 = 1	For circulation to Survey Parties.
Trace of triangulation chart of district Hazara	$\frac{1}{2}$ = 1	For Executive Engineer.
Insertion on 4-mile map of the boundaries of districts Bannu and Peshawar, and overlap surveyed in district Kohat	$\frac{1}{4}$ = 1	For Surveyor-General.
Map coloring.	No. of sheets.	
Maps colored for Surveyor-General's Office	96	
Maps colored for Revenue Survey Office	96	
Maps colored for despatch to India Office	650	Exclusive of cadastral maps.
Maps colored for issue to Government officials	987	
Total ...	1,829	
Examination of proof-sheets.		
Photozincograph proofs ...	194	
Lithograph proofs ...	42	
Examination of Original Maps.		
District Sirsa, of seasons 1876 to 79	4 = 1	132 sheets, of which 10 per cent. were finally examined and corrected and defects communicated to Executive Officer.
Do. Budaun „ 1875 to 79	4 = 1	210 sheets, of which 10 per cent. were examined and corrected, and defects communicated to Executive Officer.
Do. Cuttack „ 1877 to 79	4 = 1	24 sheets examined for publication.
Do. Banda „ 1876 to 77	4 = 1	79 sheets ; first examination completed.
Deccan Topographical Survey (Bombay), 1877 to 79 ...	2 = 1	6 sheets examined and corrected for press, and defects brought to notice of Executive Officer.
Ditto do. do. 1879-80	2 = 1	6 sheets ; first examination completed.

Table B.—*concluded.*

Title of Map.	Scale.	Remarks.
Traverse data, &c., supplied.	Inch. Mile.	
Of districts Dacca and Mymensingh along Dalesseri River ...	.....	For Commissioner, Dacca Division.
Of Jumna and Ganges Rivers ...	.....	„ Do. do.
Of districts Jaunpur and Oudh ...	.....	„ Deputy Supdt., No. 6 Party.
Of Banghi Khell Hills ...	.....	„ Do. No. 1 „
Of districts Azamgarh and Ghazipur	.....	„ Do. No. 4 „
Of Sind along the Runn of Cutch ...	.....	„ Surveyor-General.
Of district Budaun, description of bench-marks, Sections I to XX ...	.....	„ Irrigation Department, N.-W. P.
Computations examined.	Season.	
District Moradabad ...	1871 to 77	Examination of a percentage has been made in each district with the original maps, and the defects found have been communicated to the Executive Officers.
„ Budaun ...	1875 to 78	
„ Cuttack ...	1877 to 79	
„ Muttra ...	1871 to 74	
Miscellaneous work.		
Detail statement of the publication of the 4″ maps of the N.-W. P., showing numbers, &c., of original maps on record, &c. ...	.....	For N.-W. P. Government.
Revised area statements of Districts Muttra, Midnapore, Hooghly, and Jhung, according to revised limits	.....	For record.
The correction of maps and records according to changes notified in Gazettes, &c.	.....	For local governments, and office record.
Calculation of co-ordinates for the projection of the 1″ standards of districts Dera Ismail Khan and Bannu, Midnapore, Balasore, Noakholly, Backergunge, and Budaun	.....	For use in preparation of maps for publication.

Deputy Surveyor-General's Office;
Calcutta, the 1st October 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

Table C.

State of Publication of Cadastral Maps up to the 30th September 1880.

Districts.	Number of Sheets.								
	Maps prepared.			Published.					
					During 1880.				
	Up to 31st December 1879.	Added during past 9 months.	Total up to 30th September 1880.	Up to 31st December 1879.	By Surveyor-General's Office.	By Calcutta Firms.	By Allahabad Press.	Total up to 30th September 1880.	Remaining to be published.
N.-W. Provinces.									
Agra	2,894	(*a*)48	2,942	2,894	39	.....	.....	2,933	(*g*)9
Azamgarh	930	.....	930	930	.....	.....	.....	930	.....
Banda	(*b*)3,319	(*a*)10	3,329	(*b*)1,823	566	.....	.....	2,389	940
Bijnor	31	.....	31	.....	31	.....	.....	31	.....
Ghazipur	245	(*c*)1,441	(*c*)1,686	245	335	.....	.....	580	1,106
Humirpur	2,926	.....	2,926	2,926	.....	.....	.....	2,926	.....
Jaunpur	(*b*)1,052	(*c*)1,401	(*c*)2,453	1,036	738	.....	.....	1,774	679
Moradabad and Tarai	4,023	.....	4,023	4,023	.....	.....	.....	4,023	.....
Muttra	1,058	.....	1,058	1,058	.....	.....	.....	1,058	.....
Mirzapur	.....	(*c*)882	(*c*)882	.....	181	.....	.....	181	701
Total ...	17,078	3,782	20,860	15,535	1,890	.....	.....	17,425	(*d*)3,435
British Burma.									
Bassein	.....	510	510	.....	.....	.....	.....	.....	510
Hanthawaddy... ...	.....	1,043	1,043	.....	.....	.....	.....	.....	(*e*)1,043
Total ...	.....	1,553	1,553	.....	.....	.....	.....	.....	1,553
Bengal.									
Patna and Gya ...	3,054	.....	3,054	3,054	.....	.....	.....	3,054	.....
Shahabad	4,924	.....	4,924	4,924	.....	.....	.....	4,924	.....
Pooree (Khorda estate)	3,359	.....	3,359	.....	1,010	.....	.....	1,010	(*f*)2,349
Total ...	11,337	.....	11,337	7,978	1,010	.....	.....	8,988	2,349
Grand Total, N.-W. Provinces, Burma, and Bengal ...	28,415	5,335	33,750	23,513	2,900	.....	.....	26,413	7,337

(*a*)—Added owing to re-arrangement of sheets.
(*b*)—Figures of last return changed to agree with final publications.
(*c*)—These figures are approximate and liable to alteration.
(*d*)—Increase is chiefly owing to this statement being made up to 30th September instead of 31st December as heretofore.
(*e*)—61 have been sent to press.
(*f*)—Publication discontinued at request of Board of Revenue, pending final disposal of maps.
(*g*)—All at press.

Detail of Examination in connection with Publication.

Province.	Number of Sheets.					Remarks.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Colored and subsequently examined.	Printed maps examined and returned.	
North-Western Provinces	2,270	87	1,916	1,890	812	Scale 16 inches to a mile.
British Burma	61	.....	.....	.....	.....	Ditto.
Bengal	654	17	1,010	600	.....	Scale 32 inches to a mile.
Total ...	2,985	104	2,926	2,490	812	

Deputy Surveyor-General's Office;
Calcutta, 1st October 1880.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1879 AND 30TH SEPTEMBER 1880.

Work done for the Survey Department.

DESCRIPTION OF MAPS.		Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies.	Number of impressions.	Value.	REMARKS.
New Maps, &c., drawn during the year.									Rs. A. P.	
GENERAL MAPS.										
Map of Assam, in 9 sheets, sheets Nos. 6, 7 and 8, and title sheet No. 9.	Drawn on transfer paper.	1 inch = 8 miles	Imperial ...	3	305	300	605	1,365	1,252 6 11	
Map of India, in 2 sheets, sheets Nos. 1 and 2.	Corrections, additions, and chalk hills drawn on stone.	1 inch=64 miles	Double royal	2	...	520	520	1,040	1,617 15 8	
Map of India, in 6 sheets, sheet No. 2.	Drawn on polished stone.	1 inch=32 miles	Double elephant.	1	...	.....	.....	.....	184 7 2	Not yet printed.
Ditto ditto ditto ...	Drawn on grained stone.	Ditto	Ditto ...	1	...	.....	.....	.....	184 7 2	Ditto.
Outline map of India	Drawn on stone	1 inch=128 miles	Imperial ...	1	...	.....	.....	.....	93 5 0	Ditto.
INDEX MAPS.										
Index to the sheets of district Rajshahye.	Corrections and additions made.	.....	Half-sheet, double royal.	1	...	282	282	282	72 9 5	
Index to the sheets of district Maldah.	Ditto ditto ..	.....	Ditto ...	1	...	282	282	282	56 15 6	
Index to the sheets of the map of Assam	Corrections, &c., made.	.....	Foolscap ...	1	...	182	182	182	32 4 8	
Index maps, Nos. 1, 2, 5, 6, 7 and 8 and 9, parties to accompany Annual Report.	Re-drawn on stone.	.....	Ditto ...	6	...	.....	.....	.....	406 0 7	Not yet printed.
REVENUE SURVEY MAPS.										
Map of district Maldah, in 7 sheets, sheets Nos. 1, 2, 4, 6A, and 7.	Drawn on transfer paper.	1 inch = 1 mile	Double royal	5	...	1,410	1,410	1,410	1,777 6 1	
Map of district Maldah, in 7 sheets, sheet No. 6.	Ditto ...	Ditto	Ditto ...	1	...	.....	.....	.....	381 3 4	Not yet printed.
Map of district Julpaiguri, in 13 sheets, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13.	Ditto ...	Ditto	Ditto ...	13	...	.....	.....	.....	2,270 8 0	Ditto.
Map of district Nowkholly, in 12 sheets, sheets Nos. 3, 8, 9, and 12.	Ditto ...	Ditto	Ditto ...	4	...	.....	.....	.....	563 14 7	Ditto.
Map of Oudh Revenue Survey, sheets, Nos. 100, 129, and 144, 2nd edition.	Ditto ...	Ditto	Ditto ...	3	...	.....	.....	.....	478 9 4	Ditto.
Maps transferred from Engraved sheets of the Atlas of India.										
GENERAL MAPS.										
Map of Indian Atlas, quarter sheets, Nos. 66 S.-W. and 71 N.-E.	Corrections and colour stones prepared.	1 inch = 4 miles	Half-sheet atlas	2	185	65	250	585	110 9 6	
Map of Indian Atlas, full sheet, No. 111.	Corrections, additions, &c., and colour stones prepared.	Ditto	Antiquarian ...	1	150	50	200	500	218 15 0	
Ditto ditto ditto, Nos. 68 and 103.	Corrections and additions made.	Ditto	Ditto ...	2	...	.....	.....	.....	277 4 9	Not yet printed.
Ditto ditto ditto, No. 104.	Corrections, additions, and colour stone prepared.	Ditto	Ditto ...	1	...	.....	.....	.....	115 9 5	Ditto.
DISTRICT MAPS.										
Map of district Mymensingh ...	Corrections and additions made.	1 inch = 4 miles	Antiquarian ...	1	...	.....	.....	.....	27 5 0	Ditto.
Do. of ditto Dacca	Ditto ditto	Ditto	Atlas ...	1	...	.....	.....	.....	31 9 3	Ditto.
Do. of ditto Furreedpore ...	Ditto ditto	Ditto	Ditto ...	1	...	.....	.....	.....	53 8 0	Ditto.
Do. of ditto Backergunge ...	Ditto ditto	Ditto	Ditto ...	1	...	.....	.....	.....	68 3 0	Ditto.
Do. of ditto Nowkholly ...	Ditto ditto	Ditto	Imperial ...	1	...	.....	.....	.....	15 14 11	Ditto.
Do. of ditto Sylhet	Ditto ditto	Ditto	Atlas ...	1	...	.....	.....	.....	54 0 2	Ditto.
Maps, &c., drawn previously, but printed during the present year.										
GENERAL MAPS.										
Map of Assam, in 9 sheets, sheet No. 2.	Corrections, additions, and colour stones prepared.	1 inch = 8 miles	Imperial ...	1	150	50	200	500	778 13 4	
Ditto ditto, sheet No. 3	Colour stones prepared.	Ditto	Ditto ...	1	155	50	205	515	109 7 10	
Ditto ditto, sheet No. 5	Ditto ...	Ditto	Ditto ...	1	155	50	205	519	66 12 0	
Sketch map of the countries between Hindustan and Caspian Sea.	Coloured by hand	1 inch = 64 miles	Double elephant.	1	...	675	675	675	301 9 8	
INDEX MAP.										
Index to the sheets of district Furreedpore.	.....	.....	Half-sheet, double royal.	1	...	282	282	282	56 7 2	
Carried over ...	.....	.....	.....	60	1,160	4,198	5,298	8,127	11,555 2 11	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1879 AND 30TH SEPTEMBER 1880.

Work done for the Survey Department.

DESCRIPTION OF MAPS.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies.	Number of impressions.	Value.	REMARKS.
								Rs. A. P.	
Brought forward ...	.....	.....	60	1,100	4,198	5,298	8,127	11,555 2 11	
REVENUE SURVEY MAPS.									
Map of district Furreedpore, in 13 sheets, sheets Nos. 4 and 13.	.....	1 inch= 1 mile	Double royal...	2	...	564	564	564	696 14 0	
Map of district Rajshahye, in 11 sheets, sheets Nos. 5, 6, 7, 8, 9, 10, and 11.	.....	Ditto ...	Ditto ...	7	...	1,974	1,974	1,974	1,485 1 7	
Map of district Maldah, in 7 sheets, sheets Nos. 3 and 5.	.....	Ditto ...	Ditto ...	2	...	564	564	564	256 4 5	
Maps, &c., transferred previously from the engraved sheets, but printed during the present year.									
DISTRICT MAPS.									
Map of district Rungpore ...	Further corrections and additions made and colour stone prepared.	1 inch= 4 miles	Atlas ...	1	100	50	150	250	80 11 8	
Ditto Dinagepore ...	Ditto ...	Ditto ...	Double elephant.	1	150	50	200	350	90 14 7	
Ditto Shahabad ...	Ditto ...	Ditto ...	Antiquarian ...	1	150	50	200	350	184 1 9	
Ditto Julpaiguri ...	Ditto ...	Ditto ...	Imperial ...	1	150	50	200	500	121 4 7	
Ditto Gya	Ditto ...	Ditto ...	Double royal...	1	150	50	200	350	112 8 7	
Reprints.									
GENERAL MAPS.									
Outline map of India, in 2 sheets, sheets Nos. 1 and 2.	Colour stones prepared.	1 inch=64 miles	Double royal...	2	150	31	181	960	236 4 6	
Outline map of India, No. 2A ...	Corrections of railways and colour stones prepared.	1 inch=128 miles	Imperial ...	1	100	63	163	463	122 14 1	
Sketch map of the Provinces of Bengal, Behar, and Orissa.	.....	1 inch=32 miles	Double royal...	1	...	25	25	25	11 7 0	
Map of Jamoo Territories, in 3 sheets, sheets Nos. 1, 2, and 3.	.....	½ inch = 1 mile	Special ...	3	...	300	300	300	196 5 5	
Map of Eastern Bengal, sheet No. 10.	Colour stone prepared.	1 inch = 8 miles	Imperial ...	1	150	50	200	350	57 13 6	
Map of Punjab, sheet No. 1 ...	.....	Ditto	Double royal.	1	...	100	100	100	34 11 2	
Do. of British Burmah, Pegu Division, sheets Nos. 3 and 4.	.....	1 inch = 4 miles	Special and Antiquarian.	2	...	68	68	68	47 0 0	
Index Maps, to accompany Annual Report.									
Index maps, Nos. 1, 2, 5, 6, 7, 8, and 9 parties.	Corrections and colour stones prepared.	.....	Foolscap ...	6	2,400	300	2,700	5,500	417 5 10	
Index to the Indian Atlas, showing state of the Engraving to 1st October 1879.	Ditto ...	.....	Ditto ...	1	400	50	450	850	69 8 0	
Outline map of India, showing the progress of the Imperial Survey up to 1st October 1879.	Ditto ...	1 inch=128 miles	Imperial ...	1	400	.....	400	1,600	163 12 8	
DISTRICT MAPS.									
Map of district Darjeeling ...	.....	1 inch = 4 miles	Double royal	1	...	100	100	100	24 4 9	
Do. of ditto Tipperah and Noakholly, with chauk hills.	.....	Ditto	Imperial ...	4	...	150	150	1,200	59 15 6	
Map of district seaikot	.....	1 inch = 2 miles	Atlas	2	...	150	150	300	59 15 6	
Total ...	.....	.....	.....	102	5,400	8,937	14,337	24,855	16,094 6 0	
Miscellaneous maps, &c.	.....	.....	.....	16	...	.....	2,458	2,703	649 2 2	
Departmental forms	.....	.....	.....	41	...	.....	24,452	31,712	3,769 3 4	
GRAND TOTAL ...	.....	.....	.....	159	5,400	8,937	41,247	59,265	20,512 11 6	

Work done for other Departments.

NAMES OF DEPARTMENTS.	Number of maps.	Number of sheets.	Number of sheets coloured.	Number of sheets uncoloured.	Number of copies.	Number of impressions.	VALUE.
							Rs. A. P.
Foreign Department	13	13	1	12	768	1,138	779 14 9
Military ditto	18	34	5	29	3,690	5,989	1,956 4 0
Home, Revenue and Agricultural Department	5	9	.....	9	1,380	2,160	821 14 4
Telegraph Department	6	6	.....	6	4,188	5,148	519 2 0
Bengal Office	18	18	.....	18	29,828	7,408	808 0 2
Marine Survey Department	3	3	1	2	296	728	214 2 1
Sanitary Commissioner	2	2	1	1	886	2,826	488 13 1
Quartermaster-General	58	58	.....	58	6,794	6,071	503 14 3
Meteorological Reporter to the Government of India ...	9	9	3	6	4,407	5,388	628 8 10
Archæological Survey of India	52	52	.....	52	37,180	19,305	4,498 0 11
Geological Survey of India	2	2	2	.....	1,486	7,831	655 5 4
Miscellaneous drawings	80	80	12	68	28,197	21,024	5,059 5 4
Maps, &c., drawn, but not printed	37	52	11	41	.....	.....	1,418 9 4
Total ...	303	338	36	302	1,19,100	85,016	18,351 14 5

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1879 AND 30TH SEPTEMBER 1880.

Statement of Type Work executed, exclusive of value of Transfers, &c., already included in the cost of the several Lithographic Maps, &c.

SUBJECTS.	Items.	Number of copies.	Number of impressions.	VALUE.
				Rs. A. P.
Circular orders	11	1,310	1,310	42 9 0
Memoranda, &c.	475	1,74,026	2,33,511	3,692 9 0
Forms, &c., for Survey Department	46	59,024	1,30,526	2,560 6 0
Transfers of headings, foot-notes, references to published maps, for Photographic Branch.	1,801	19,953	19,953	2,039 4 0
Total ...	2,333	2,54,313	3,85,300	8,334 12 0

General abstract of out-turn and value of work performed.

SUBJECT.	Number of sheets.	Number of copies.	Number of impressions.	VALUE.
				Rs. A. P.
DEPARTMENTAL WORK.				
General and district maps, &c.	36	5,647	12,955	5,955 11 2
Index maps	11	4,178	7,378	705 2 7
Revenue survey sheet maps, scale 1 inch=1 mile	16	4,512	4,512	4,225 10 1
Miscellaneous maps, &c.	16	2,458	2,708	649 2 2
Departmental forms	41	24,452	31,712	3,769 3 4
Maps drawn, but not printed	39	.....	.....	5,207 14 2
Total ...	159	41,247	59,265	20,512 11 6
Work done for other Departments	338	1,19,100	85,016	18,351 14 5
Total of drawing and printing in Lithographic Department ...	497	1,60,347	1,44,281	38,864 9 11
Work done in Type Department	2,333	2,54,313	3,85,300	8,334 12 0
Total value ...	.....	.....	.....	47,199 5 11

Statement of Expenditure.

	Rs. A. P.
Establishment	34,077 2 8
Contingent charges	4,976 9 1
Total ...	39,053 11 9

SURVEYOR GENERAL'S OFFICE,
LITHOGRAPHIC BRANCH,
Calcutta, 9th November 1880.

R. V. RIDDELL, *Captain*, R.E.,
Assistant Surveyor-General,
In charge Lithographic Branch,
Surveyor General's Office.

Extract from a Report by MAJOR S. H. COWAN, R.E., *Assistant Superintendent, Survey of India Officiating in charge of the Photographic Branch, Surveyor-General's Office—Season* 1879-80.

I HAVE the honour to submit the usual tabular statements showing the amount of work performed in this branch of your office during the past year, from 1st October 1879 to 30th September 1880.

A comparison of the out-turn with that of the previous year is presented in the following table:—

	Ordinary Work.				Cadastral Maps.				Remarks.
	1879-80.	1878-79.	Difference.	Difference in square inches.	1879-80.	1878-79.	Difference.	Difference in square inches.	
Original sections	1,409	1,222	+187	.....	3,673	3,941	−268	.....	
Negatives... ... ... No.	1,928	1,322	+606	.....	2,886	3,401	−515	.....	
Ditto square inches ...	5,93,190	4,73,323	.....	+1,19,868	22,16,448	26,09,432	.....	−3,92,984	
Photograph transfer ... No.	1,933	1,189	+753	.....	3,115	3,359	−244	.....	
Ditto square inches ...	5,95,979	4,31,017	.....	+1,64,953	23,92,320	25,76,264	.....	−1,83,944	
Silver prints ... ... No.	1,028	192	+836	.....	.....	.....	.....	.....	
Ditto inches	1,11,064	42,220	.....	+68,844	.....	.....	.....	.....	
Pigment prints ... ... No.	29	245	−216	.....	.....	.....	.....	.....	
Ditto inches	8,452	1,01,092	.....	−92,640	.....	.....	.....	.....	
Platinum prints ... No.	.....	.....	.....	.....	.....	.....	.....	.....	
Ditto inches	.....	.....	.....	.....	.....	.....	.....	.....	
Transfers to zinc	1,313	1,064	+249	.....	3,661	4,162	−501	.....	
Number of pulls	1,23,150	1,12,014	+13,136	.....	1,18,681	1,03,150	+15,531	.....	
Ditto of printed sheets, single.	2,56,670	1,45,012	+1,11,658	.....	1,18,681	1,03,150	+15,531	.....	
Ditto ditto ditto, combined.	2,40,309	1,26,334	+1,13,975	.....	64,031	56,125	+7,906	.....	
Proofs	1,282	3,159	−1,877	.....	3,622	7,528	−3,906	.....	

The increase in the ordinary work is due to the great demand for maps of Afghanistan.

The cadastral work has proceeded regularly throughout the year, at a rate considerably below the full power of the establishment. The supply of originals in the Revenue Office ran low during the cold weather of 1879-80, and the supply was only kept up by receipts of maps surveyed in the same season. But since June 1880, when the Board of Revenue, North-Western Provinces, directed that the system of congregating several small adjoining villages in one sheet should be discontinued and each village published by itself as a separate map, the work of the zincographers has been very heavy. For example, in one batch of eight sheets received from the Revenue Survey Office, there were 50 different villages. These were photographed on eight negatives, from which eight transfers were prepared and put down on zinc. From each plate as many retransfers were pulled as there were villages in the sheet; from each retransfer all the villages but one were cut out, and this one, with its proper title, adjoining village names, and notes, was put down on a zinc plate by itself. Previous to the issue of this order, sheets containing congregated villages were printed as they stood, 25 copies being supplied for each village on the sheet.

The expenditure of the office during the same period (Survey year, 1879-80) has been as follows:—

	Rs. A. P.	Rs. A. P.
Superintendent's salary	10,862 2 1	
Establishment	24,107 4 9	
House-rent and taxes	4,482 13 6	
Contingencies	1,898 10 7	
		41,350 14 11
Chemicals, &c., received from England	4,840 4 4	
Ditto ditto Medical Store Department	57 12 0	
Stores and materials received, other departments	629 3 3	
Paper received from England and Government Stationery Department	3,004 6 10	
Books and periodicals received from England, no invoice ..	.....	
		8,531 10 5
Cadastral Surveys.		
Establishment	21,155 3 0	
Contingencies	4,696 0 0	
		25,851 3 0
Chemicals and stores received from England	20,191 1 6	
Ditto ditto ditto Medical Store Department ...	105 0 0	
Stores and materials from other departments	386 12 6	
Paper received	4,350 12 3	
		25,333 10 3
Total ...	1,01,067 6 7	1,01,067 6 7

The total expenditure for the previous year, 1878-79, was Rs. 1,02,348-14-2.

The necessity, on financial grounds, for the separation of the cadastral expenditure on wages, chemicals, stores, and contingencies from the corresponding expenditure on ordinary office work has long been a great inconvenience. If carried out strictly, it would

have prevented the transfer or loan of labour or materials from the office s ide to the cadastral or *vice versâ*, unless the smallest item could be brought to account, which was hardly practicable when the work of the two branches was going on side by side in the same rooms. And, further, no charge was made against the cadastral branch for su perintendence, house-rent, and some other items, of all of which a large share was fairly debitable to it. Until it could be authoritatively decided what this share should be, it was impossible to draw up a regular scale of charges for work done in the ordinary office branch.

Your proposal to the Government of India, in December 1879, to include the expenditure of the Cadastral Branch in the Survey budget and recover from the different Provincial Governments the value of the cadastral maps supplied to them at the fixed rate (for 1880-81) of Rs. 15 for 25 copies of each photozincographed map and Rs. 10 for 25 copies of each zincographed map, has enabled this office to dispense with separate indents for the chemicals and stores required for the two branches* and to use a fixed scale of charges for work done.

* The establishment bills will still be kept separate.

No changes have been made during the year in the processes regularly used, nor has any new process been introduced. The work of the office is, as before, almost confined to photozincography, the amount of silver prints, pigment prints, carbon prints, collotypes, and platinum prints being comparatively very small. A method of multiplying copies of circulars, rough drawings, &c., invented in Germany and extensively used in England (where it is known as the hektograph, multiscripts, &c., &c.), was tried and found to succeed here, and a quantity of the necessary materials for working it was made up and supplied to officers in Afghanistan.

Statement showing the Value of the Work done for other Departments from 1st October 1879 to 30th September 1880.

Names of Departments.	Number of sections.	Number of negatives.	Number of complete copies.	Number of silver and other prints.	Cost. Rs. A. P.	Remarks.
Government of India, Foreign Department.	6	5	1,500	.....	113 11 0	
Government of India, Military Department.	39	36	1,742	.....	580 10 9	
Government of Punjab, Public Works Department.	2	11	300	.....	340 6 3	
Government of Bengal	2	2	550	.....	98 2 6	
Inspector-General of Military Works	59	131	11,795	.....	4,094 15 6	
Quartermaster-General ...	127	116	8,751	.....	2,950 15 3	
Director of Garrison Instruction ...	2	2	250	.....	76 12 0	
Inspector-General of Ordnance ...	22	5	22,500	.....	635 10 0	
Marine Survey Department ...	20	47	7,830	.....	2,363 15 8	
Port Office	12	26	1,021	.....	906 10 3	
Geological Survey of India ...	1	1	617	.....	49 13 6	
Director-General of Railways ...	1	3	475	.....	151 14 9	
Manager, Rajputana State Railway...	5	1	500	.....	134 2 6	
Engineer in Chief, Western State Railway.	11	11	900	.....	267 0 0	
Executive Engineer, Public Works Department, N. N. State Railway.	12	10	3,600	.....	306 0 0	
Executive Engineer, Architect and Building Department of Public Works.	9	19	390	.....	72 11 5	
Superintending Engineer, West Jumna Canal.	33	33	495	.....	1,086 7 0	
Superintending Engineer, West Sone Circle.	1	4	110	.....	90 0 0	
Chief Engineer, East Indian Railway	1	1	200	.....	60 0 0	
Superintendent, Carriage and Wagon Department, East Indian Railway.	1	4	50	.....	69 2 0	
Executive Engineer, Benares Division	5	4	500	.....	715 4 7	
Ditto, Calcutta Municipality.	17	11	1,050	.....	263 0 9	
United Service Institution ...	13	14	12,610	.....	1,040 14 9	
Asiatic Society	3	2	6,000	.....	237 3 0	
Deputy Commissioner, Amraoti, Berar	1	4	20	.....	105 0 0	
Private Secretary to His Honor the Governor of Bombay.	1	1	100	.....	32 12 0	
Sir Robert Sandeman, K.C.S.I. ...	.....	.....	18	.....	31 1 10	
Captain R. Beavan	.....	.....	10	.....	5 0 0	
Assistant Engineer, Beluchistan ...	.. ...	.....	2	.....	1 0 0	
F. S. Grouse, Esq., Officiating Deputy Magistrate and Collector.	13	2	3,900	.....	56 15 9	
E. C. Buck, Esq.	... ..	.....	.....	700	248 0 0	Silver and platinum.
Superintendent, Government Printing	39	8	106,926	.....	1,404 12 10	
Captain Cole, R.E.	2	6	150	.....	140 0 0	
Principal Thomason College ...	3	6	500	.....	36 10 6	
Inspector-General of Police, Bengal..	1	1	200	.....	55 12 6	
Meteorological Reporter to Government.	1	1	460	.....	43 4 9	
Irrigation Department, Public Works Department, Punjab.	12	24	2,760	.....	1,388 0 6	
Forest Department	39	39	558	.....	960 10 3	
Colonel Tanner	.....	.....	.....	26	52 0 0	Silver.
Total ...	516	591	199,130	726	21,266 8 4	
Cadastral, North-Western Provinces (Photozincographs).	2,160	2,160	58,616	.....	33,126 14 0	
Cadastral, North-Western Provinces (Zincographs).	367	Nil	9,369	.....	3,476 12 0	
Cadastral, Burma (Specimen Photozincograph).	1	1	120	.....	27 13 0	
Cadastral, Bengal (Photozincographs)	941	941	40,463	.....	15,761 12 0	
„ „ (Zincographs) ...	73	Nil	3,139	.....	857 12 0	
Total Cadastral ...	3,542	3,102	1,11,707	.....	53,250 15 0	
Grand Total ...	4,058	3,693	3,11,137	726	74,517 7 4	

S. H. COWAN, *Major*, R.E.,

Offg. Asst. Surveyor-General, in Charge Photographic Branch, Surveyor-General's Office.

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Extract from the Narrative Report of J. B. N. HENNESSY, ESQ., M.A., *Deputy Superintendent, First Grade, in charge Head-quarters Office, Trigonometrical Branch, Dehra Dun, for* 1879-80.

COMPUTING BRANCH.

Calculating Branch.

THE following cost-table of work done in the Computing Branch is similar to the corresponding tables exhibited in the reports for previous years:—

Cost-table in Rupees, 1879-80.

CLASSES.	October.	November.	December.	January.	February.	March.	April.	May.	June	July.	August.	September.	Average per cent.
1. Records, library	63	60	31	42	44	56	100	70	54	38	25	17	2¼
2. Computations	177	301	238	234	202	398	319	321	369	474	306	578	16
3. Accounts, returns, correspondence	454	333	208	342	239	201	377	428	380	407	493	433	17
4. Supply	22	33	98	45	68	126	31	32	55	71	101	28	3
5. Press-copy	437	293	350	405	503	708	359	444	411	354	326	288	20
6. Press-proofs	279	283	211	235	231	219	300	312	289	260	313	360	13
7. Charts	16	24	16	32	...	23	12	12	50	32	18	47	1
8. Stations	65	63	29	124	139	28	88	88	126	68	31	81	3½
9. Leave, holiday	196	457	649	386	265	176	263	184	38	163	171	51	12
10. Miscellaneous	323	253	270	167	259	165	245	209	328	268	341	242	12
Total ...	2,081	2,100	2,100	2,100	2,100	2,100	2,100	2,160	2,100	2,125	2,125	2,125	100

Classes 2 and 5 are intimately connected, and are best considered in combination. They indicate a percentage of 36 against 32½ of last year—an increase due chiefly to the wants of officers who, having returned from the frontier, needed help in getting through the calculations of their field results. Otherwise, the average percentages above shown are nearly as usual.

Calculating branch.

The particulars of the work, indicated in a general manner in the preceding table, are given hereafter in such detail as seems desirable.

Class 1, *Records, Library.*—The work under this head shows a small decrease in the average per cent as compared with former years.

Class 2, *Computations.*—

Principal Triangulation (in duplicate).

SOUTHERN TRIGON.—Reduction of quadrilateral figures, computed	... ...	2
Ditto simple polygonal figures, computed	... ...	6
Ditto compound figures, computed	... ...	2
Spherical excesses, computed	... ...	35
Principal triangles, corrected	... ...	35
Latitudes, longitudes, and azimuths computed (single deductions)	...	28

Secondary Triangulation (in duplicate).

N. W. QUADRILATERAL AND N. E. QUADRILATERAL. (Chiefly Kumaun and Garhwal, and Jodhpore series).	Traverses, computed	25
	Triangles, ditto or adjusted	550
	Ditto, feet and miles only, computed... ...	80
	Latitudes, longitudes and azimuths, computed or corrected	360
	Auxiliary azimuths, computed...	175

BELUCHISTAN TRIANGULATION.—

Triangles, computed	360	NOTE—This kept a pair of computerss teadily at work *(without interruption)* for *three* whole months.
Ditto, feet and miles only, computed	150	
Latitudes, longitudes, and azimuths computed	270	
Heights, computed	237	
(Besides, preparing synopsis of results, abstracting angles, horizontal and vertical, &c., &c.)		

OBSERVED LATITUDES.—Reduced North Polar distances of 140 stars from six different catalogues to epoch 1850. Computed results of fourth and fifth visits to Kaliampur, giving values of the latitude of that station by 40 and 30 pairs (respectively) of North and South stars. Computed latitude of Dodagunta from observations by Colonel Lambton, 9 values by North stars and 7 values by South stars.

The work performed under this class cannot be *tabulated* further. It may, however, be added that a few sets of time, latitude, and barometric observations were reduced for officers returned from Afghanistan. Some Actinometric observations taken at head-quarters were reduced. Two new auxiliary tables were computed, xxxiii of 35 pages (mile equivalents in feet and links for ·001 to 10 miles), and xxxiv for finding the subtended angle from an observed vertical to a point not visited. Tables were also computed for incorporation in the volume of electro-longitude work, &c., &c., &c.

Class 4, *Supply*.—Data in manuscript has been supplied to 20 officers. In a few instances this involved considerable time in preparation. Over 800 despatches of forms, maps, charts, books, &c., have been made.

Class 5, *Press Copy* —

N. W. QUADRILATERAL.—SYNOPTICAL VOLUME VII.—Prepared tables of errata, addenda, references and contents.

JODHPORE SERIES.—Compared data for plates; tables illustrative of *final reduction;* in hand, secondary triangles (so far as computed).

EASTERN SIND SERIES.—Prepared (in part) descriptions of stations, abstract of angles, sums of squares and reductions of figures.

S. E. QUADRILATERAL, VOLUME VI.—Prepared some tables which were wanting to complete the set required for illustration of account of final reduction, vocabulary of native terms, contents and errata et addenda.

Synoptical Vol. X.
Ditto „ XIII.

Prepared addendum to descriptions of principal stations; also put together Vizagapatam tidal observations for incorporation in Introduction of volume xiii.

SYNOPTICAL VOLUME XII.—Introduction written.

N. E. QUADRILATERAL, VOLUMES VII AND VIII.—Prepared (in part) table of contents; introduction, including account of final grinding, *partly* done; Introductory accounts of triangulation on Budhon, Rangir, and Amúa series, about three-fourths done; also

EAST CALCUTTA LONGITUDINAL SERIES.—Azimuth and co-ordinate lists prepared.

ASSAM LONGITUDINAL SERIES.—Azimuth and co-ordinate lists compared.

EASTERN FRONTIER SERIES, CALCUTTA MERIDIONAL SERIES.—Co-ordinate lists examined and corrected.

NORTH PARASNATH SERIES; NORTH MALUNCHA SERIES; KARARA SERIES.—Examined generally and re-arranged the co-ordinate lists.

S. W. QUADRILATERAL.—Description of principal stations, Singi series, compiled, and those of *all* the series of this quadrilateral compared. Reduction of figures finished for about the fourth of the quadrilateral which remained undone at time of last *report*.

SOUTHERN TRIGON.—Reduction of figures compiled for great arc, sections 8 to 12; Bombay, longitudinal; Mangalore, meridional; Madras, longitudinal; South Konkan, Ramnad, longitudinal; and Madras coast series (needs comparison). Abstract of observed angles, sums of squares table, and table showing E. M. S. of observation and graduation prepared for the entire trigon. The two latter subjects need comparison.

OBSERVED LATITUDES.—Completed collection and tabulation as below :—

(1)—Lists of stations arranged alphabetically, chronologically, and latitudinally.

(2)—A preliminary station table, giving name of station, series, latitude, longitude, observer, instrument, date, number of stars observed north and south, number of observations (in general) to each star, and total number of observations.

(3)—Lists of stars observed at each of the 104 stations, furnishing 117 distinct sets of observation.

(4)—List of all stars arranged according to right ascensions in six sub-lists, corresponding to as many catalogues and periods.

(5)—A general compilation of all the 906 stars observed, showing the several catalogues in which they are or are not forthcoming, number of determining measures, and other parts necessary for further progress.

(6)—A general list of all stars arranged according to right ascensions, showing the several stations at which they have been observed, &c., &c.

(7)—A similar list, with argument, North Polar distance, and furnishing in addition the years in which each star was observed, &c., &c.

ELECTRO-LONGITUDE VOLUME.—Seventeen forms for publication of results prepared after discussion, according to instructions received from Lieutenant-Colonel Campbell; some transcription done; and all press copies sent in by Colonel Campbell examined generally before sending to the printer.

MISCELLANEOUS.—Spirit leveled heights No. 1, Bombay Presidency.—Tables of contents and errata prepared (the latter is being extended). No. 2, Bombay Presidency.—Manuscript examined generally, and tables of contents and errata prepared Letter press compiled for preliminary chart of the Beluchistan series. Also letter press examined for preliminary chart of Kelat series, Eastern Frontier series (1877-78), and Burma secondary triangulation (1878-79). Several pages of observed angles have been abstracted for the Eastern Frontier series, south of 23°.

Class 6, *Press Proofs*.—This class is not susceptible of explanatory remarks. It has cost during this year rather less than the average percentage as compared with that of former years.

Class 7, *Charts*.—Examined or compared—

Final ...	Reduction chart of the N. E. quadrilateral. Budhon meridional series. Rangir ditto ditto. Karara. Chendwar.
Preliminary ...	Kelat series, season 1879-80. Eastern Frontier series, season 1877-78. Madras Coast series, season 1878-79.
	Index chart of secondary triangulation in British Burma (for office use).
	Rough chart of southern trigon (for office use).

In addition, examined plates showing the figures of the Brahmaputra series (for illustrating professional volume of N. E. quadrilateral), skeleton chart of principal triangulation (for illustrating professional volume vi); also examined generally, chart illustrating pamphlet of spirit levels No. 2, Bombay Presidency.

Class 8, *Stations*.—Of additional duplicate lists one has been completed, making a total of 337 districts accounting for 3.197 stations, and four supplementary lists descriptive of 24 stations have been issued to district officials.

Class 10, *Miscellaneous*.—Cause of discrepancy between values of spirit-leveled points about Hubli, as obtained by operations southwards from Bombay, and northwards from Bangalore, examined into and reported on. Pages of several hundred pamphlets of spirit levels arranged preparatory to stitching. Distribution list for synoptical volumes carefully prepared. Adie's new standard barometer compared and examined, with the object of eliciting the causes of large fluctuations in the corrections due thereto, especially between morning and evening observations. New range (1 to 500 yards) for the Mussoorie Volunteer Rifles, measured. Quarterly list of maps and charts published at Dehra furnished to Surveyor-General's Office at Calcutta; and three sets of pages printed at Dehra regularly forwarded to the same office for safe custody. Help afforded to various officers going to, or returning from, the Frontier. 49 sets of time observations to the sun, taken and reduced. Meteorological observations taken at Dehra twice daily on every day of the year, and at Mussoorie for six months; the results for Dehra supplied to the Meteorological Reporter to the Government, North Western Provinces, and daily weather telegrams for Mussoorie as well as the anemograms for both Dehra and Mussoorie supplied to the Meteorological Reporter to the Government of India.

TYPOGRAPHIC BRANCH.

The work annually performed by this branch during the past five years is briefly given in the following table, where the unit (a page of foolscap) is the same throughout.

	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.
Pages composed	1,179*	1,535	2,050	1,844	1,421
„ printed	349,000	495,573	630,894	590,043	494,136

* Averages for a twelve-month.

An analysis of the pages composed, furnishes the following—

	Pages.		Pages.
For volume V ...	129	For Synoptical volume VII ...	21
„ „ VI ...	279	Ditto volumes of N. E. Q. ..	217
„ volumes VII and VIII ...	36	Ditto of S. E. Q. ...	8
„ „ of S. W. Q. ...	260		246
„ „ of electro-longitude ...	46	For pamphlets of spirit-leveled heights ...	76
	740	For auxiliary and other working tables ...	55
		Charts, orders, memoranda, &c. ..	304

Total ... 1,421 pages.

Photo-zincographing Branch.

The following are details of the work executed by this Branch:—

MAPS.

Subject.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	.....	83	4,945
Guzerat survey, sheet No. 28, section North-Western ... ... (*For Irrigation Department, Bombay*)	October 1879 ...	1	17
Guzerat survey, sheet No. 28, section South-Western ... ... (*For Irrigation Department, Bombay*)	,, ,, ...	1	18
Guzerat survey, sheet No. 6, in four sections ... ... (*For Irrigation Department, Bombay*)	,, ,, ...	4	132
Tirah and the neighbouring country	,, ,, ...	2	307
Kumaun and Garhwal *forest* map, sheet No. XXXIV *(for Forest Department)*	,, ,, ...	1	58
Parts of Arabia and Persia, sheets 1, 2, 3 *(for Colonel Ross, Political Resident, Persian Gulf)*	,, ,, ...	3	52
Plan of the country around Moré *(Plate VIII of Vol. V of the Account of the Operations, &c.)*	November ,, ...	1	364
View of Moré Plain *(Plate IX of the Account of the Operations, &c.)*	,, ,, ..	1	444
Eye-sketch of the Route-march from Patta Kissar Ferry to Herat	,, ,, ...	1	52
Hundes or Narikhorsum and Monyul	,, ,, ...	2	252
Parts of Arabia and Persia, sheets 4, 6, 7 *(for Colonel Ross, Political Resident, Persian Gulf)*	,, ,, ...	3	54
Dehra Dun and Siwaliks (1-inch scale), sheet No. 1	,, ,, ...	1	179
Index to Cutch survey	,, ,, ...	1	424
Dehra Dun and Siwaliks (1-inch scale), sheet No. 2	December ,, ...	1	211
Ditto ditto (ditto), ditto 3	,, ,, ...	1	214
Index to Guzerat survey	,, ,, ...	1	462
Do. to Kattywar ditto	,, ,, ...	1	480
Plan of Government Botanical Gardens, Saharunpore (for Superintendent of the Garden)	,, ,, ...	1	107
Guzerat survey, sheet No. 6	,, ,, ...	1	171
Map of Explorations in Sikkim and Great Tibet, by Explorer L. (1875-76)	,, ,, ...	1	446
Guzerat survey, sheet No. 29, section 1	,, ,, ...	1	88
Sketch Map of the Darjeeling Division, Bengal, *(for Forest Department)*	,, ,, ...	1	387
Guzerat survey, sheet No. 7	January 1880 ...	1	180
Parts of Arabia and Persia, sheets 8, 10, 11, 12, *(for Colonel Ross,, Political Resident, Persian Gulf)*	,, ,, ...	4	66
Dehra Dun Municipality and Cantonment	,, ,, ...	2	319
Kattywar survey, sheet No. 60	,, ,, ...	1	134
Ditto do. ,, 51	,, ,, ...	1	137
Gilghit and surrounding country	February ,, ...	1	137
Kattywar survey, sheet, No. 41	,, ,, ...	1	135
Ditto do. ,, 52	,, ,, ...	1	130
Guzerat survey, do. ,, 7, section N. W.	,, ,, ...	1	33
Route-map from Herat to Obe through Rousebagh and Kurukh	March ,, ...	2	54
Guzerat survey, sheet No. 49, section 1	,, ,, ...	1	84
Ditto do. do. 9	,, ,, ...	1	86
Ditto do. No. 7, do. S. E.	,, ,, ...	1	84
Ditto do. do. S. W.	,, ,, ...	1	33
Kumaun and Garhwal *forest* map, sheet No. LIII *(for Forest Department)*	,, ,, ...	1	56
Guzerat survey, sheet No. 7, section 1	April ,, ,,	1	87
Ditto do. ,, 7, do. 2	,, ,, ...	1	87
Ditto do. ,, 7, do. 3	,, ,, ...	1	85
Ditto do. ,, 7, do. N. E. *(for Bombay Irrigation Department)*	,, ,, ...	1	35
Sketch Map of territory between Cabul and the Mustagh Pass *(for Major Biddulph)*	,, ,, ...	1	303
Guzerat survey, sheet No. 6, section 2	,, ,, ...	1	86
Ditto do. ,, 27	,, ,, ...	1	180
Kumaun and Garhwal *forest* map, sheet No. XVII *(for Forest Department)*	May ,, ...	1	65
Ditto ditto ditto No. XXXV *(for ditto)*	,, ,, ...	1	66
Ditto ditto ditto ,, XLI *(for ditto)*	,, ,, ...	1	70
Guzerat survey, sheet No. 25	,, ,, ...	1	190
Ditto do. ,, 49, section 11	,, ,, ...	1	90
Ditto do. ,, 49, do. 12	,, ,, ...	1	80
Turkestan map, sheet No. 2 (reduced to half scale)	,, ,, ...	1	7
Kumaun and Garhwal *forest* map, sheet No. XXIII *(for Forest Department)*	June ,, ...	1	67
Kumaun and Garhwal *forest* map, sheet No. XXXIX *(for ditto)*	,, ,, ...	1	66
Ditto ditto ditto No. XL *(for ditto)*	,, ,, ...	1	67

MAPS—*continued.*

Subject.	When published.	Number of parts.	Number of sheets printed.
Kattywar survey, sheet No. 53	June 1880 ...	1	136
Guzerat do. do. ,, 27, section N. E. *(for Irrigation Department, Bombay)*	,, ,, ...	1	20
Turkestan map, sheets Nos. 1 and 2 [tin-foil retransfers] ...	,, ,, ...	2	4
Guzerat survey, sheet No. 27, section North-Western	July ,, ...	1	20
Guzerat survey, sheet No. 27, section South-Eastern ... ... *(For Irrigation Department, Bombay)*	,, ,, ...	1	17
Guzerat survey, sheet No. 27, section South-Western	,, ,, ...	1	19
Guzerat survey, sheet No. 6, section 1	,, ,, ...	1	88
Ditto do. ,, 7, do. 4	,, ,, ...	1	85
Ditto do. ,, 27, do. 1	,, ,, ...	1	95
Ditto do. ,, 27, do. 2	,, ,, ...	1	85
Ditto do. ,, 27, do. 3	,, ,, ...	1	117
Ditto do. ,, 27, do. 4	,, ,, ...	1	87
Sketch Map to illustrate progress of recent surveys beyond the Sind Frontier	,, ,, ...	1	58
Kattywar survey, sheet No. 39	,, ,, ...	1	89
Reconnaissance of the Tarnak and Khushki Rud Valleys, from Shahjui to Kandahar	August ,, ...	1	240
Map of Sibi and the Lower Bolan	,, ,, ...	1	116
The Tarnak and Ghazni Valleys, from Shahjui to Ghazni ...	,, ,, ...	1	244
Sketch Map of Ghazni and the surrounding country ...	,, ,, ...	1	227
Kumaun and Garhwal *forest* map, sheet No. LII *(for Forest Department)*	September ,, ...	1	70
Guzerat survey, sheet No. 26	,, ,, ...	1	158
Cutch and the Runn	,, ,, ...	1	12
Total ...	.....	173	15,100

Besides the foregoing, 588 blue prints, and 1,021 silver prints (433 subjects) were prepared for the use of the Engravers and for Executive Officers.

CHARTS.

Subject.	When published.	No. of parts.	No. of copies printed.
Gora Meridional series ... ... Final	Dec. 1879 ..	1	375
Eastern Frontier series, season 1877-78 ... Preliminary	Jan. 1880 ...	1	67
Thyetmyo *vid* Prome, &c., to Cape Negrais (secondary) season 1878-79 ... ... ,,	,, ,, ...	1	61
Trans-Indus Triangulation (portion of) by Lieutenant J. T. Walker, R.E. ... . Rough	,, ,, ...	1	22
North Maluncha Meridional series ... ... Final	Feb. ,, ...	1	370
Amúa Meridional series ... ... ,,	,, ,, ...	1	345
Madras Coast series, season 1878-79 ... ... Preliminary	,, ,, ...	1	65
Kumaun and Garhwal Triangulation, 1864-78 ... Rough	,, ,, ...	2	69
Ditto ditto, 1871-72 ... ,,	March ,, ...	1	33
Budhon Meridional series ... ... Final	,, ,, ...	1	340
Triangulation in Northern Afghanistan ... Rough	May ,, ...	1	55
Chart illustrating Pamphlet of Spirit-leveled Heights, No. 2, Bombay Presidency	June ,, ...	1	505
Chart showing Chains of Principal Triangulation west of 92° ...	,, ,, ...	1	332
Reduction chart of the South Maluncha Meridional series, Final	July ,, ...	1	381
Ditto ditto Párásnath ditto ,,	,, ,, ...	1	417
Rangir Meridional series ... ... ,,	August ,, ...	1	384
Total ...	.....	17	3,821

DIAGRAMS.

Subject.	When published.	No. of copies printed.
Polygons and other figures to illustrate figural reductions for volumes of the Great Trigonometrical Survey, Bench-marks, &c.	Nov. 1879...	588
	March 1880...	8
	May ,, ...	14
	June ,, ...	20
	August ,, ...	684
	Sept. ,, ...	957
		2,271
Professional and Office Forms	1879-80...	17,230
Labels for packing synoptical volumes, Great Trigonometrical Survey ...	.....	679

The total number of negatives taken is 909, the number of chromo-carbon prints, 1,070, and the number of transfers to zinc, 196.

Contrasting the work performed since 1875-76 we have :-

Year.	Maps.	Blue-prints.	Silver-prints.	Charts.	Diagrams.	Forms, &c.
1875-76	14,025	12	126	1,678	9,722	18,314
1876-77	12,348	108	189	9,225	3,956	21,384
1877-78	12,481	195	426	4,531	4,877	23,736
1878-79	20,229	1,394	353	2,642	2,603	20,070
1879-80	15,100	588	1,021	3,821	2,271	17,909

An abstract of the work executed during the past five years stands thus :—

Subject.	Number of Prints.				
	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.
Maps, charts, and diagrams	25,425	25,529	21,889	25,474	21,192
Blue-prints	12	108	195	1,394	588
Silver-prints	126	189	426	353	1,021
Forms, &c.	18,314	21,384	23,736	20,070	17,909

The decrease in the total number of maps, as compared with the total for the previous year, is due to the circumstance that the latter total included no less than 8,568 copies of Afghanistan and Turkestan maps, while in 1879-80 the number of copies of these maps printed, was below 500.

Drawing Branch.

16. The work performed in this Branch is as follows :—

Description of Work.	No. of Sheets or Diagrams.		Scale one inch = miles.	Remarks.
	Finished.	In hand.		
Final Charts.				
Rangir Meridional series	1	.....	4	For reduction by photo-zincography.
Budhon ditto	1	.....	4	
Gufwáni ditto	1	.....	4	
Karára ditto	1	.....	4	
Huriláong ditto	.....	1	4	
Chendwar ditto	1	.....	4	
Calcutta ditto	1	.....	4	
Reduction chart of the South Párasnáth series	1	.....	4	
Ditto of the South Malúncha series	1	.....	4	
Ditto of the North-East Quadrilateral ...	1	.....	16	
Ditto of the Jodhpur Meridional series ...	1	.....	4	
Skeleton chart of principal chains of triangulations west of Meridian of 92°	1	.....	96	
Preliminary Numerical Charts				
Beluchistan series, season 1877-79	.....	1	4	For reproduction on full scale by photo-zincography.
Kelat ditto 1879-80	1	.....	4	
Kandahar ditto 1878-79	1	.....	4	
Compilation.				
Spirit-leveled heights, sheets 75, 80, and 82	.....	3	2	For photo-zincography.
Parts of Arabia and Persia for Colonel E. C. Ross, Political Resident, Persian Gulf, in extension of his map ...	2	.....	12	
Map of the Kuram and Khost Valleys surveyed in 1879 by Major Woodthorpe, R.E., and Captain Martin, S.C. ...	1	.....	4	
Preliminary maps of parts of Afghanistan, sheets 1, 2, and 3, for Captain C. Strahan, &c.	3	.....	1	
Preliminary map of part of Afghanistan for Captain C. Strahan, &c.	1	.....	4	
Sketch Map of territory between Kabul and the Mustagh Pass, for Major Biddulph	1	.....	16	
Language Map of countries between Kabul and Leh, for ditto.	1	.....	32	
Turkestan Map, sheets Nos. 3 and 4 (5th edition) ...	2	.....	32	

Description of Work.	No. of Sheets or Diagrams.		Scale one inch = miles.	Remarks.
	Finished.	In hand.		
Compilation—*concluded*.				
Atlas reductions of sheets 1 and 2, Kumaun and Garhwal survey.	2	2	Atlas scale.	For incorporation in atlas sheets.
Atlas reductions of sheets 1, 2, and 3, Dehra Dun and Siwaliks survey.	1			
	Sections.	Sections	Miles.	
Levels in the Sindh Sagar Doab, Derajat Circle	12	4	2	For level sheets.
Map of Sibi and the Lower Bolan, by Major Beavan ...	1	.....	2	For photo-zincography.
Sketch Map to illustrate recent survey operations beyond the Sind Frontier	1	.....	16	For photo-zincography.
Miscellaneous.				
Prepared a trace of "The Mullah's" map of explorations for the Foreign Office	1	.....	8	To accompany Narrative.
Prepared rough chart of the Southern Trigon	1	.....	12	
Drew "The Mullah's" route-map to illustrate his report ...	... ..	1	8	Suspended.
Completed Colonel Tanner's Map of country round Gilghit ...	1	.....	4	For photo-zincography
			Versts.	
Prepared tracings of map of route from Obe to Herat ...	2	.....	2	Ditto.
			Miles.	
Revised, corrected, and enlarged route-map of Western Himalayas, Punjab, &c....	.....	1	32	For engravers.
Prepared forms, professional and others	16	.....	.....	For photo-zincography.
Prepared rough charts of the following :— (1)—Colonel Tanner's and Captain C. Strahan's points in Afghanistan. (2)—Quetta triangulation. (3)—Rays to Peaks, Lieutenant Walker's triangulation (Trans-frontier.) (4)—Khanpisura series. (5)—Eastern Sind series (approximate)				
Prepared rough charts for Major Leach, Captain Holdich, and Colonel Tanner	... ..	.....	.....	
Drew rough map of explorations by "The Mullah," "Havildar" and other explorers	1	.....	8	For silver prints.
Prepared tracings of the Bari Doab and Rechna Doab Canals, sheets	.....	.....	.....	For level sheets.
Prepared descriptions and diagrams of bench-marks of above-named canals, and of the bench-marks of the Sind Sagar Doab Canals	.....	.....	.....	
Prepared tracing of contoured map of Bannu Valley and Index Map of leveling operations of Sind Sagar Doab ...	.....	.....	.....	
Inserted boundaries in charts of the following triangulations :— (1) Assam Valley; (2) North-Eastern Longitudinal series; (3) Eastern Calcutta Longitudinal series.				
Examined, corrected, and passed for the press, original maps of topographical surveys	36	.....	Various scales...	For photo-zincography.
Examined and passed for the press, proofs of maps and charts Coloured, 8,838 maps.	254	.....	Ditto.	
In hand, the new list of maps and charts in Drawing Office.				

In addition to the foregoing, considerable help was afforded to Captain Holdich and Major Woodthorpe in shading the fair sheets of their surveys, and in sorting and despatching various maps (originals, prints, &c.) that had accumulated at Mussoorie from the collections brought in by Frontier Officers; besides other miscellaneous duties required chiefly in connection with the war in Afghanistan.

Correspondence and Stores.

The year's correspondence is represented by about 1,300 letters and some 600 office Memos. &c. The wants of Trans-frontier Officers were necessarily large. In all, of instruments 175 were despatched, and 298 received; of stores, 11 articles despatched and 23 received; presenting a total of 56 packages, and 47 parcels despatched, and of 116 packages and 198 parcels received.

Solar Photography.

As mentioned in last report the solar photography work was suddenly interrupted by the death of the photographer, Mr. M. Meins. The work was resumed, under orders from the Secretary of State, by Mr. L. H. Clarke, Surveyor, 2nd grade, after sufficient training,

on 17th December 1879. The period under review comprises 289 days, of which the working facts will be found in the following table.

1879-80.	Number of Days.					Number of Negatives.						Number of Days when Solar Phenomena were	
	Negatives taken.	Failures.		Total.	Runs.	Solar Phenomena.						Visible.	Absent.
		Bad weather.	Various causes.			Spots and faculæ.	Spots only.	Faculæ only.	None.	Total.			
December	8	6	1	15	7	.....	9	.....	6	22		5	10
January	25	6	.....	31	23	14	17	6	9	69		19	12
February	21	7	1	29	15	18	9	1	7	50		17	13
March	28	.....	3	31	21	84	9	2	8	74		23	8
April	23	1	.....	30	24	13	18	3	17	75		18	12
May	28	3	.....	31	23	22	16	6	4	71		26	6
June	24	6	.....	30	18	11	28	2	.....	59		24	6
July	18	13	.....	31	13	3	9	2	9	36		11	20
August	23	5	.....	31	17	18	22	.....	6	63		23	8
September	25	5	.....	30	13	8	34	.....	.....	60		25	5
Total ...	232	52	5	289	179	141	171	22	66	579		191	98

Total number of silver prints—1,346.

From above, and from facts of preceding reports, may be gathered—

With regard to bad weather, when the sun was invisible throughout the day, the percentages are—

1877-78	...	...	...	... 9 in 100 days,	obtained	from 273	days.
1878-79	...	...	...	... 11	ditto	ditto	89 ,,
1879-80	...	...	...	... 14	ditto	ditto	289 ,,

The last is reckoned on the complete year of 365 days, because when the work was in abeyance in October and November bad weather very rarely occurs.

Again, as regards visible solar phenomena, we have—

1877-78	...	... Phenomena visible on	27	in 100 days	obtained	from 273 days.
1878-79	...	...	25	ditto	ditto	89 ,,
1879-80	...	...	66	ditto	ditto	289 ,,

from which the increase in so called "solar activity," as measured by number of days, when features were visible, is obvious. In all, Mr. Clarke took 579 negatives including runs, and prepared 1,346 silver prints; the weekly despatch of these to the India Office was made with the usual punctuality.

Mean Velocity in miles of the winds which blew at Dehra Dun during twelve months of 1879-80 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	1·61	1·62	1·43	1·55	1·62	1·50	2·13	·77	·80	·03	·13	·12
1 „ 2	1·06	1·10	1·29	1·45	1·31	1·83	1·50	·74	·77	·00	·13	·12
2 „ 3	1·10	·72	1·04	1·39	1·24	1·23	1·00	·71	·77	·00	·13	·28
3 „ 4	1·03	·66	·61	·97	·97	1·00	·70	·39	·30	·03	·03	·08
4 „ 5	·70	·41	·68	1·10	1·14	·73	·73	·19	·27	·10	·00	·20
5 „ 6	·60	·62	·32	·68	·90	·73	·70	·23	·20	·06	·03	·29
6 „ 7	·40	·45	·61	·87	·59	·73	·47	·42	·23	·23	·00	·08
7 „ 8	·20	·31	·50	·58	·59	·47	·57	·32	·53	·13	·10	·00
8 „ 9	·43	·18	·32	·42	1·34	·37	·70	·39	·73	·13	·10	·16
9 „ 10	·63	·54	·48	·61	1·17	1·07	1·47	·77	1·10	42	·32	·56
10 „ 11	1·07	·96	1·03	1·23	1·59	1·97	1·67	1·97	1·63	·39	·29	·56
11 „ 12	1·43	1·36	1·31	1·35	2·10	2·03	2·47	1·97	1·77	·68	·35	·60
12 „ 13	1·71	1·52	1·64	1·68	2·14	2·27	2·83	1·94	1·70	·68	·52	·83
13 „ 14	1·52	1·62	1·79	1·58	2·34	2·17	2·93	1·94	1·77	·74	·48	·83
14 „ 15	1·42	1·55	1·86	1·74	2·41	2·37	3·23	3·00	2·07	·94	·81	·58
15 „ 16	·90	·93	1·54	1·52	3·24	2·70	3·63	2·97	2·57	·61	·42	·75
16 „ 17	·19	·10	·46	·87	1·79	1·53	2·33	2·58	2·33	·32	·42	·42
17 „ 18	·39	·24	·25	·32	1·45	·57	1·00	2·61	1·67	·19	·42	·21
18 „ 19	1·39	1·03	·64	·48	·93	·07	·50	2·13	·47	·19	·16	·17
19 „ 20	1·90	2·07	1·50	1·06	1·17	·57	1·13	1·74	·33	·13	·19	·21
20 „ 21	1·84	2·41	1·89	1·71	1·21	1·73	1·87	2·03	·37	·13	·42	·21
21 „ 22	2·19	2·10	1·93	1·52	·93	2·40	1·90	2·10	·53	·00	·32	·17
22 „ 23	2·19	2·31	1·54	1·65	1·45	2·17	2·17	1·35	·43	·00	·13	·13
23 „ 24	1·77	1·90	1·57	1·42	1·45	1·80	1·93	1·16	·77	·06	·13	·25
Sums ...	27·67	26·71	26·23	27·75	35·07	34·01	39·56	34·42	24·11	6·19	6·03	7·72
Average ...	1·15	1·11	1·09	1·16	1·46	1·42	1·65	1·43	1·00	0·26	0·25	0·32

Monthly Meteorological results taken from the Register kept at the Head-quarter's Office, Trigonometrical Branch, Survey of India, Dehra Dun.

Year and Month.	Barometer. At 9-30 A. M. Highest.	Barometer. At 9-30 A. M. Lowest.	Barometer. At 9-30 A. M. Monthly Mean.	Barometer. At 3-30 P. M. Highest.	Barometer. At 3-30 P. M. Lowest.	Barometer. At 3-30 P. M. Monthly Mean.	Hygrometer. At 9-30 A. M. Monthly mean temperature of dew point.	Hygrometer. At 9-30 A. M. Monthly mean humidity.	Hygrometer. At 3-30 P. M. Monthly mean temperature of dew point.	Hygrometer. At 3-30 P. M. Monthly mean humidity.	Thermometer. Dry Bulb. Maximum in sun's rays.	Thermometer. Dry Bulb. Minimum on grass.	Thermometer. Dry Bulb. Maximum in air.	Thermometer. Dry Bulb. Minimum in air.	Thermometer. Wet Bulb. Monthly mean in air.	Thermometer. Wet Bulb. Maximum wet.	Thermometer. Wet Bulb. Minimum wet.	Thermometer. Wet Bulb. Monthly mean wet.	Rain. Number of days it fell.	Rain. Fall in inches.	Wind. Most frequent direction.	Cloud. At 9-30 A. M.	Cloud. At 3-30 P. M.
1879.																							
October ...	27·831	27·567	27·697	27·735	27·468	27·608	61·5	·680	63·2	·565	103·5	43·6	86·5	52·9	71·5	77·5	46·0	63·5	4	·52	N.	1	2
November ...	·873	·675	·783	·790	·595	·702	47·4	·599	47·9	·432	93·0	31·4	78·2	40·0	61·4	65·2	36·7	52·5	...	.....	S.W.	...	1
December ...	·904	·681	·797	·804	·584	·710	41·1	·618	41·2	·431	85·2	29·2	72·0	36·9	55·0	59·0	33·5	47·3	2	·66	S.S.W.	2	2
1880.																							
January ...	·928	·594	·742	·843	·527	·664	46·2	·730	47·2	·493	90·5	31·5	76·1	38·2	56·5	70·2	36·7	50·3	3	1·67	S.S.W.	2	3
February ...	·852	·435	·713	·763	·455	·640	47·7	·743	48·8	·565	86·7	29·0	75·5	35 0	56·9	62·4	33·9	50·2	8	3·90	S.S.W.	5	6
March ...	·821	·472	·658	·729	·370	·558	55·6	·548	57·1	·409	106·8	42·0	91·8	48·8	71·4	74·3	44·9	60·0	...	.....	S.S.W.	1	2
April ...	·707	·463	·582	·591	·381	·483	55·2	·396	51 4	·266	115·4	51·9	98·2	60·2	80·0	75·5	48·8	63·7	3	·31	S.W.	2	3
May ...	·643	·405	·510	·547	·289	·413	61·5	·453	61·4	·407	118·7	56·1	101·0	60·8	81·7	81·0	54·4	67·4	8	2·47	S.S.W.	2	5
June ...	512	·218	·362	·428	·164	·282	70·1	·597	68·1	·501	121·7	62·7	106·4	68·1	86·7	87·2	54·0	73·5	12	9·10	W.	5	6
July ...	·494	·289	·397	·433	·238	·337	74·7	·862	76·3	·841	109·6	68·0	90·0	70·5	79·1	81·4	66 5	74·6	26	33·34	S.E.	8	9
August ...	·569	·371	·452	·470	·295	·377	73·6	·778	75·1	·708	110·8	66·3	91·0	68·9	80·3	80·6	65·5	74·4	17	16·97	S.W.	5	6
September ...	·763	·440	·581	·635	·350	·494	70·7	·775	71·9	·727	108·3	61·6	90·5	65·0	77·4	79·1	62·3	71·7	12	13·44	N N.W.	4	6

Note.—The height of the Barometer cistern above mean sea-leve. at Karachi is 223·41 feet.

Reg. No. 12216J—350—26-3-81.

Extract from the Proceedings of the Government of India, Home, Revenue and Agricultural Department (Surveys),—No. , dated Simla, the May 1881.

READ—

General Report on the Operations of the Survey of India during the year 1879-80, submitted with the Surveyor General's letter No. 908; dated 2nd April 1881.

RESOLUTION.—The third report of the amalgamated Department of the Survey of India deals, as usual, with the surveys in process of execution by the Trigonometrical, Topographical, and Cadastral Survey parties, with geographical and miscellaneous operations, and with the work of the head-quarter offices at Calcutta and Dehra Dún.

2. The Surveyor General reports that, in respect to Peninsular India, the principal triangulation of the whole country may now be regarded as fully completed. In Northern India the small chain of triangles which has yet to be executed will probably be finished within a few months. During the year three parties were employed on principal and one on secondary triangulation. Colonel Branfill, whose skill and energy in the conduct of the modern operations in Southern India are commended in the Report, brought the work of the Madras coast party to a close. After an interval of nearly a century, a regular series of triangles has thus been now laid down between Madras and Cape Comorin; and a branch series has been extended to connect the Survey of India with that of Ceylon. Colonel Branfill's party also executed some secondary triangulation, fixing the positions of the light-houses at Pondicherry and Negapatam, and linking a chain of triangles extending northwards to Ponáni with one brought down from the Mangalore longitudinal series of 1873-74. In Eastern Sind, under the orders of Captain Rogers, an area of 1,278 square miles was covered by principal triangulation; the chain of secondary triangles between Khelat and Quetta was finished; and a work of much immediate practical value, that of reducing the operations and preparing the charts of the triangulation between Jacobabad, Quetta, Khelat, Kandahar, and in the Khakrez valley was carried on by Mr. Hennessey. The Eastern Frontier party was occupied in Siamese territory in the neighbourhood of Bankok. Its progress was somewhat impeded by sickness and other difficulties; but Captain Hill cordially acknowledges the assistance which he received from the Siamese Government and the British Consul. To this party belonged the late Mr. H. Beverley, whose services had been assiduous and successful, and whose death, at a comparatively early age, is much regretted. In British Burma an inconsiderable amount of secondary triangulation was effected around and to the north of Bassein. The triangulation between Rangoon and the main-land opposite the Krishna shoal was abandoned; and, instead of it, a traverse was executed forming one of the main circuits on which the cadastral survey of the Hanthawaddy district will be based.

3. Topographical surveys were in progress in Mysore, the Deccan, Khandesh, Guzerat, Kattywar and Cutch, Rajputana and Central India, in the Muzaffarnagar and Meerut districts of the North-Western Provinces, and in the Sylhet district of Assam. Eleven parties in all were engaged upon these operations, as in the preceding year. The Mysore party was to a great extent employed in mapping the Mysore and Kanara Frontier for the use of the Boundary Commission; 1,911 square miles of detailed topography were executed in the Malnad forests; and 188 square miles in the vicinity of Bangalore. The smallness of the outturn is explained by sickness and the exceptional character of the country. The total area surveyed by the party up to the end of last field season amounts to 9,316 square miles, chiefly in the Nundydroog division. About two-thirds of the State, or 18,000 square miles, remain to be surveyed in detail, of which the greater part has been covered by preliminary triangulation in advance. Of the two Deccan parties, one in the south accomplished an outturn of 2,028 square miles of topography, principally around Sholápur, but including also a small portion of the Konkan south-west of Mahábaleshvar. Large scale maps of the city and cantonment of Satára were also completed. Further northwards, in the part of the Konkan prepared by preliminary triangulation during

the preceding season, the topographical survey was commenced by the second party in a hilly country covered with dense jungle. Eleven hundred and fifty square miles were also surveyed in the Deccan above the Ghats. The Khandesh party, in addition to some triangulation and traversing, completed the detail of a tract to the west and north-west of Dhulia in the Khandesh district, including the upper basin of the Pánjhra valley. The work of the Guzerat party is published on various scales—1-inch, 2-inch, and 4-inch respectively. Ordinary topography was in progress in the Ahmedabad, Broach, and Surat Collectorates, and in the Baroda, Mahi Kánta, Rewa Kánta and Sachin States. The 4-inch forest survey of the Dangs was continued. The outturn of topography executed by this party was somewhat diminished by causes similar to those which impeded the party in Mysore. With the completion of the district of Okhámandal, at the western extremity of the Kattywar peninsula, the general survey of that province came to an end. The question whether it is necessary to fill in the breaks in the boundaries of the taluks or sub-divisions of the several Native States, can, if still undecided, be determined by the Government of Bombay. In Cutch 1,639 square miles were finally surveyed on the 2-inch scale for reduction to the 1-inch scale on publication. The topographical delineation of Rajputana proceeds rapidly, as a desert country offers few obstacles to the surveyor; and an area of 6,928 square miles was mapped in the Bikaneer State. The Rajputana party, in addition to its topographical work, produced a map, on the 12-inch scale, of the city of Bikaneer, and made progress with the 24-inch surveys of the Solon and Dagshai cantonments in the Simla hills. The operations of the Gwalior and Central India party were not carried on within the territory indicated by its name. It was employed, during the season under notice, in the south of the Rajput State of Oodeypore, and in a tract to the east of the Lúni river, near Sindri, within the State of Jodhpore. The outturn was small, but the country was difficult; a great part of it resembling, in the words of Major Steel, "a petrified stormy sea." The area topographically surveyed in detail by the Malwa party in the Jhábua State of Central India was also partly and for similar reasons less than might have been expected. Its operations included a map on the 6-inch scale of the city and environs of Dhár in the Native State of that name. In the Meerut division of the North-Western Provinces, where a 2-inch topographical survey of the districts between the Ganges and the Jumna is gradually progressing from north to south, the work in the Muzaffarnaggar district was brought to a close; whilst an area of about 400 square miles was mapped in the north of the Meerut district. The objects of Major Badgley's party in the Sylhet district of Assam are of a rather special character. Waste lands, which have been or may be taken up for tea cultivation, are being mapped, and a forest survey is being carried on in the south-east corner of the district. The party effected little, having been hampered by want of carriage and compelled, by heavy rain and floods, to leave the field at an unusually early date. The season, moreover, was unhealthy; and the work lay amongst dense forests, or in swampy ground. Looking to general results throughout the country, it is observed that, notwithstanding the serious difficulties which, in several instances, hindered or restricted the operations, the total outturn of topography does not compare very unfavourably with that of the previous year, as will be apparent from the following figures:—

Area surveyed topographically in square miles.

Scale.	1878-79.	1879-80.	Increase or decrease.
½-inch	5,424	7,138	+1,714
1-inch	8,778	4,794	—3,984
2-inch	9,179	9,664	+485
4-inch	218	117	—101
Total ...	23,599	21,713	—1,886

There is thus a net decrease of 1,886 square miles. The most considerable diminution is in the outturn of area surveyed on the 1-inch scale; and this is

due to the decreased amount of work executed by the Gwalior and Central India, Malwa, and Mysore parties. In each of these cases an explanation of the circumstances which retarded progress has been given in the Report of the Surveyor General.

4. The village or mauzawar surveys on the 4-inch scale were much less extensive than in the preceding year, owing to the break-up of the party which, after the completion of the Sirsa district, had been destined for, and had actually begun work in, Jhelum. The outturn of the year was 2,118* square miles, as against 4,491 in 1878-79; and nearly the whole of this area lay in the Punjab. In point of fact, the village revenue survey of the old type, which was the usual concomitant or precursor of settlement operations before the work of detailed field measurement was made over, as is now generally the case, to professional surveyors, was restricted to the single district of Dera Ismail Khan. A fair outturn was obtained in the Bhakkar tahsil of this district, amounting to 1,334 square miles of the cis-Indus *Thal*, a tract forming part of the generally barren and sandy grazing grounds which constitute the great triangular expanse between the Indus and the Jhelum. The party has yet to execute the survey of about 3,800 square miles in the *Thal* of Dera Ismail Khan and Muzaffargarh. The 4-inch forest survey of the Murree and Kahuta tahsils in the Rawalpindi district was completed; some forest reserves were mapped in the plains; and some preliminary work was effected in the Kala Chitta hills lying between Attock and Pindigheb. All the other 4-inch surveys were more or less special in character and very limited in extent. The survey of the Khorda Government estate in the Pooree district of Bengal had hitherto been classed as a cadastral survey; but, as mentioned in last year's review, a change of system has been introduced, the interior village measurements being made by the Settlement Department, and the professional party supplying boundaries and the details of the hills. In the previous Report, it was anticipated that the work in Khorda would be finished by September 1880: but this expectation does not seem to have been realised; for the map opposite page 19 of the present report shows a good deal of ground traversed in advance which was not surveyed on the 4-inch scale during the season. The area completed (125 miles of 4-inch and 40 miles of 32-inch survey) was exceedingly small, and the cost, Rs. 55,666, considerable. This amount, however, includes expenditure in completing the records of previously surveyed portions of the estate. The party suffered much from fever, and other circumstances are mentioned in the Report which contributed to reduce the outturn. The 4-inch survey of the Jumna villages between the North-Western Provinces and the Punjab was continued along the Karnál and Muzaffarnagar boundary, and covered a small strip at the north-west corner of Meerut. In the Bánda district some forest reserves were mapped on the same scale.

5. Cadastral or field surveys were prosecuted in the permanently-settled districts of the North-Western Provinces, and in several districts of the Pegu division of British Burma now coming under a regular settlement for the first time. With the exception of the trifling area of some 20 square miles, the cadastral survey of the temporarily-settled district of Bánda had been finished in the preceding season. Operations were in progress to the north of the Mirzapur district, to the south and east of the Jaunpur district, and to the west and south of Gházipur. The survey of Mirzapur began, and that of Jaunpur was almost finished. The Gházipur survey is about half done. The attention of the Government of the North-Western Provinces and Oudh will be invited to the remarks at page 24 of the report, where it is suggested that the Jaunpur party, on completion of its work, might have been suitably employed on the survey of the Benares district, which, however, the Lieutenant-Governor would, for the present, defer. At the same time the Surveyor General may consider whether the Jaunpur party might not be transferred to British Burma, if it is not required by the Government of the North-Western Provinces and Oudh.

It was mentioned in last year's review that it had not then been finally determined whether the field or the holding should be taken as the unit of survey for the professionally conducted settlement measurements in British

* This includes 40 miles of 32-inch survey in Pooree.

Burma. This question has since been decided in favour of the field. Two cadastral parties were at work in Burma—one in the Hanthawaddy district, under Captain Sandeman, and the other, superintended by Major Andrew, in Bassein. Operations have subsequently been extended to the Tharrawaddy district, as noted in the Report. The Government of India cordially concurs with the Surveyor General in acknowledging the promptitude with which the Survey Officers, and more particularly Captain Sandeman, have supplied the Settlement Department with the necessary maps and statements. This has enabled the Chief Commissioner to report the assessments of nine circles in the Syriam and Bassein townships, which were sanctioned in February last; and the Governor General in Council has much pleasure in observing that, so far, the progress made in the Burma surveys, executed, as they have been, under novel and, in some respects, difficult conditions, has been very creditable to the Survey Department. The commendable care bestowed by Captain Sandeman on the training of Burman Surveyors has been previously noticed.

6. The subject of the "miscellaneous" surveys in the Darjeeling district has been recently under discussion with the Government of Bengal. Field work in that district has now ceased; and the question of continuing the geographical survey of Sikhim, which has been partially carried out by Lieutenant Harman, the officer in charge of the Darjeeling party, will be further considered on his return from leave.

7. Of other geographical operations, the most important were those which were conducted by the Survey Officers accompanying the several columns of the Army in Afghanistan and Biluchistan during the second phase of the Afghan War. The survey has been taken for the most part on the $\frac{1}{2}$-inch or $\frac{1}{4}$-inch scale, supplemented by rough reconnaissances and by native information in the less accessible places. Generally speaking, the detailed survey extends from Pesháwar to Kabul *viâ* the Khyber pass and the Kuram valley, but excluding Bara and Tíra, and the Afridi country lying between the Pesháwar district and a line drawn a little to the north of Thal. South-west of the Kuram valley it has taken in a great part of Khost. A radius of 15 miles to the north and west of Kabul, and of 50 miles to the south in the direction of the Logar valley, would approximately cover the rest of the country mapped in Northern Afghanistan. In Biluchistan and Southern Afghanistan the area delineated is much less compact. With some breaks, which were merely reconnoitred, it may be described as reaching Girishk on the west from Fort Munro on the Dera Ghazi Khan frontier. It includes Khushk-i-Nakhud, the country around Kandahar, a great part of the Khojak-Amran range, Pishín, a tract to the north and north-east of Quetta, and the neighbourhood of Dada and Sibi along and to the west of the line of rail. The northern and southern surveys have been connected by the survey of the route from Kandahar to Ghazni through the Khushk-i-Rud, Tarnak, and Ghazni valleys. The total area mapped during the season in Northern Afghanistan is estimated at 11,180 square miles; and the Surveyor General is invited to state, in his next report, the total area mapped or reconnoitred by the Survey Department, whether in North or South Afghanistan or in Biluchistan, throughout the whole period of the military operations.

8. The Governor General in Council has again to notice with much satisfaction the distinguished and valuable services of the Survey Officers during the war. His acknowledgments are due to the military officers and the civilian surveyors mentioned by the Surveyor General in the Report; and more particularly to Captain Holdich, R.E., who was in charge of the survey of Northern Afghanistan; to Major Woodthorpe, R.E., who executed much important work in Kuram and accompanied General Ross on his march through Maidan to meet Sir Donald Stewart on his advance from Kandahar; to Lieutenant Gore, who was attached to Sir Donald Stewart's force on this occasion and effected a junction with the survey brought down by Major Woodthorpe from Kabul; to Lieutenant-Colonel E. P. Leach, V.C., whose report on his operations in Southern Afghanistan has been separately acknowledged; and to Lieutenants the Hon'ble M. G. Talbot and Longe, who were with General Sir F. Roberts on his memorable march from Kabul to Kandahar and were present at the battle which succeeded it. The Governor General in Council has further observed the foot-note at page 34 of the report which recounts the valuable service rendered

by a Native explorer near the Sherpur cantonments and in Kafiristan. The Surveyor General should report whether this man has received any special reward, and, if not, whether he deserves one.

9. The remarks of the Surveyor General on the general organization of survey operations with an army in the field will be brought to the notice of the Military Department and of the Secretary of State in continuation of previous papers on the same subject.

10. Good progress is reported in tidal operations, which is due to the efficient superintendence of Captain Baird. Tidal instruments were set up at six additional places, and observations are now made at thirteen tidal stations, *viz.*, Aden, Kurrachee, Bombay, Karwar, Beypore, Paumben, Madras, False Point, Rangoon, Elephant Point, Moulmein, Amherst, and Port Blair. The several stations are being connected by lines of spirit-levels; and levels will be taken during the course of the cadastral surveys in British Burma. The electro-telegraphic operations for the determination of differences of longitude again remained in abeyance, as no officers were available for the work.

11. The issues of maps from the Surveyor General's office in Calcutta increased from 28,737 maps, valued at Rs. 38,274 in 1878-79, to 33,796 maps, of the value of Rs. 57,005. There was a large demand for maps of Afghanistan and the North-West Frontier; and much new geographical material was utilised with great promptitude. A preliminary edition of the map of India, on the scale of 1-inch=64 miles, was published by the Lithographic Branch to meet immediate requirements. The number of cadastral maps of the North-Western Provinces published during the year was 2,527. Many of these had been plotted during the field season of 1879-80, and the great majority of them were photozincographed. Numerous maps of the Khorda Government estate were reproduced by the same process. The Mathematical Instrument Department issued during the year 14,103 instruments, valued at Rs. 1,07,230. The further details given of the working of the head-quarter offices at Calcutta do not call for any remark.

12. At Dehra Dún the work of the final reduction of the observations and measurements of the Great Trigonometrical Survey is progressing satisfactorily. Vol. VI of the account of the operations is being published; Vols. VII and VIII are under preparation; and the printing of Vols. IX and X has commenced. Three of the synoptical volumes, containing a précis of the results of the triangulation, were published, and three more were completed but not bound.

13. Several of the extracts from the narrative reports of the executive officers given in the Appendix have been read with interest. Amongst these are the notes of Colonel J. Macdonald on the Konkan, of Captain Sandeman on the Syriam township, and of Captain Holdich on the Logar valley. The remarks of Captain Heaviside, of the Khandesh Survey, on the Mangya Tungya hills and the Balsána temples, will be communicated to the Director General of the Archæological Survey. Lieutenant-Colonel Tanner's report on the surveys around Gilgit, and the translation of the notes of the Native explorer on the Irrawaddy river above Bamo, contain interesting information on remote localities hitherto little known.

14. The thanks of the Government of India are due to the Surveyor General for his able superintendence of the Department.

ORDER.—Ordered, that copies of the Resolution be forwarded to the Surveyor General of India; to the Local Governments noted in the margin; and to the Foreign and Military Departments. Also that a copy, with a copy of the Report, be sent to the Director General of the Archæological Survey of India in advertence to paragraph 13.

Madras.	Central Provinces.
Bombay.	British Burma.
Bengal.	Assam.
N. W. P. and Oudh	Coorg.
Punjab.	

True Extract,

C. GRANT,

Offg. Secy. to the Govt. of India.

1881

GOVERNMENT OF INDIA.

HOME, REVENUE AND

AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

No.

Dated Simla, the *May 1881.*

SUBJECT.

Review of the General Report on the operations of the Survey of India during the year 1879-80.

Govt. Central Branch Press, Simla.—No. 150 H., R. & A. D.—30-5-81—616

GENERAL REPORT

ON THE

Operations of the Survey of India,

COMPRISING

THE GREAT TRIGONOMETRICAL, THE TOPOGRAPHICAL, AND THE REVENUE SURVEYS UNDER THE GOVERNMENT OF INDIA,

DURING

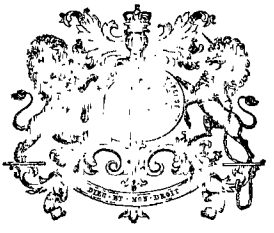
1880-81.

PREPARED UNDER THE SUPERINTENDENCE

OF

LIEUTENANT-GENERAL J. T. WALKER, C.B., R.E., F.R.S., &c.,

SURVEYOR-GENERAL OF INDIA.



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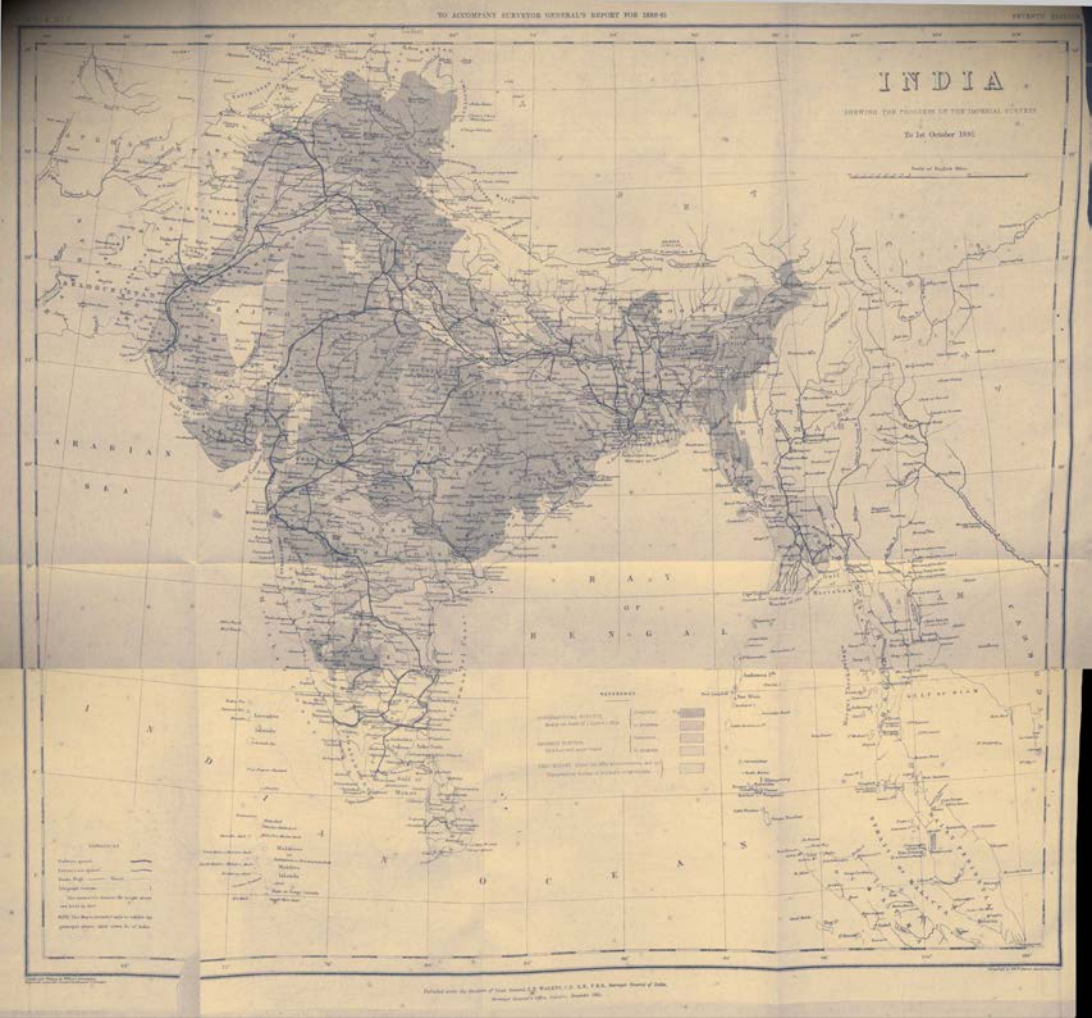


Published under the direction of Lieut. General R. S. MAUNSELL, C.B., C.S.I., F.R.A.S., Surveyor General of India.
Survey Office, Calcutta, December 1881.

GENERAL REPORT

OF THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1880-81.

INTRODUCTORY.

THE general direction of the Department, and the immediate supervision of the Trigonometrical and Topographical Branches, have been performed by Lieutenant-General J. T. Walker, C.B., R.E., Surveyor-General. The immediate supervision of the Revenue Branch has been performed by Lieutenant-Colonel J. Sconce, S.C., Deputy Surveyor-General.

2. The principal operations which have been carried out during the survey year under review, *viz.*, from 1st October 1880 to 30th September 1881, are as follows:—

Statement of Survey Operations and Parties.

Number in this Report.	Nature and Locale of Operations.	Names of Executive Officers.	Designations of Survey Parties.	Remarks.
	Triangulation.			
I	Eastern Sind	Lieut.-Col. B. R. Branfill	Bombay Party.	Principal Triangulation.
II	Eastern Frontier	Captain J. Hill, R.E.	Eastern Frontier Party	Principal Triangulation.
III	Burma	Captain J. Hill, R.E.	Burma Party.	Secondary Triangulation.
	Topography.			
IV	Central India	Major C. Strahan, R.E.	No. 1 Topographical Survey.	On 1-inch scale for reproduction.
V	Khandesh	Mr. J. McGill	No. 2 Topographical Survey.	On 2-inch scale for reduction.
VI	Malwa	Major J. R. Wilmer	No. 5 Topographical Survey.	On 1-inch scale for reproduction.
VII	Sylhet	Major W. F. Badgley, S.C.	No. 6 Topographical Survey.	On 2-inch and ½-inch scale for reduction and reproduction.
VIII	Rajputana	Colonel G. C. DePree	No. 7 Topographical Survey.	On ½-inch scale for reproduction.
IX	Mysore	Major G. Strahan, R.E.	No. 8 Topographical Survey.	On 1-inch scale, for reproduction.
X	Kohat	Major T. H. Holdich, R.E.	Kohat Topographical Survey.	On 1-inch scale, for reproduction.
XI	Guzerat	Colonel C. T. Haig, R.E.	Guzerat Survey.	2-inch scale for reproduction on same scale and reduction to 1-inch scale.
XII	Meerut Division, N.-W. P.	Major W. H. Wilkins, S.C.	No. 3 Revenue Survey.	2-inch scale for reproduction on same scale and reduction to 1-inch scale.
XIII	Cutch	Major A. Pullan, S.C.	Kattywar and Cutch Survey.	2-inch scale for reduction and ½-inch scale for reproduction.
XIV	North Deccan	Major H. L. Smith, S.C.	No. 10 Revenue Survey.	2-inch scale for reduction to 1-inch scale.
XV	South Deccan	Major D. Andrew, S.C.	No. 11 Revenue Survey.	2-inch scale for reduction to 1-inch scale.
XVI	Beluchistan	Major R. Beavan, S.C.	Beluchistan Survey.	½-inch and ¼-inch scales.

Statement of Survey Operations and Parties—concluded.

Number in this Report.	Nature and Locale of Operations.	Names of Executive Officers.	Designations of Survey Parties.	Remarks.
	Mouzawar or Village Survey.			
XVII	Rawalpindi and Dera Ismail Khan, Punjab.	Lt.-Col. D. Macdonald, S.C.	No. 1 Revenue Survey.	4-inch scale, with military camps on 12-inch scale.
	Cadastral or Field Survey.			
XVIII	Mirzapore and portions of Tarai District, N.-W. P.	Colonel F. C. Anderson, S.C.	No. 5 Revenue Survey.	16-inch scale.
XIX	Jaunpore, N.-W. P. . .	Mr. E. T. S. Johnson .	„ 6 ditto.	
XX	Ghazipur, „ . .	Major W. Barron, S.C. .	„ 4 ditto.	
XXI	Hanthawaddy and Arrakan Waste Land Grants, Burma.	Major J. E. Sandeman, S.C., and Captain J. R. McCullagh, R.E.	„ 2 ditto.	
XXII	Bassein, Burma . .	Major E. H. Steel, S.C. .	„ 8 ditto.	
XXIII	Tharawaddy, Burma. .	Mr. H. B. Talbot . .	„ 7 ditto.	
	Miscellaneous.			
XXIV	Darjeeling . . .	Captain H. J. Harman, R.E.	Darjeeling Survey.	Various scales in Darjeeling, ½-inch in Sikkim.
	Geographical.			
XXV	Afghanistan . . .			
XXVI	Surveys around Gilgit .	Lieut.-Col. H. C. B. Tanner		
	Tidal and Leveling Operations.			
XXVII	Tidal Stations on Coast Line.	Captain A. W. Baird, R.E. .	Tidal and Leveling Party.	
XXVIII	Leveling in Southern India	Ditto ditto .		
	Geodetic.			
XXIX	Electro-telegraphic determinations of longitudes in Northern India.	Lieut.-Col W. M. Campbell, R.E., and Major W. J. Heaviside, R.E.	No. 1 and No. 2 Astronomical Parties.	

Triangulation.

3. In the last report it was stated that the principal triangulation of all India, as originally designed by Colonel Everest, had been wholly completed in Southern India, and that very little—only a single season's work of a single party—remained to be done in Northern India. During the present year this little has been accomplished by the completion of the northern section of the Eastern Sind Meridional Series. All that now remains for completion is a chain of principal triangles outside the limits of India proper; it is known as the Eastern Frontier Series, which in previous years had been carried down the east coast of the Bay of Bengal and through British Burma into Tenasserim; it will probably be brought to a close on a base line of verification in Mergui during the field season of 1881-82.

4. The general out-turn of the triangulation was as follows:—In Eastern Sind a chain of principal triangles, 50 miles in length, furnishing 13 new stations, at two of which verificatory astronomical determinations of azimuth have been made; also, a secondary chain of triangles 154 miles long: the total area covered by both chains was 2,297 square miles. In Tenasserim, observations were taken at eight principal stations over a span of about 50 miles, but they were necessarily partial and the triangulation cannot be completed until next year.

Topography.

5. The regular topographical operations have been carried on in continuation of those of last year, in the same provinces and by the same parties. It happens that these parties were originally formed, some in the Trigonometrical, others in the Topographical, and others in the Revenue Departments of the General Survey, before the amalgamation of those departments into one, which was effected in January 1878. The three departments had grown up practi-

cally independently of each other, and thus various differences of procedure had arisen in the conduct of the operations; of these the most marked were that the topography and general interior survey were mainly based on triangulation in the two first departments, and on traversing in the third; and that a much larger proportion of European to Native agency was employed in the two former than in the latter. The recess offices of five topographical parties, appertaining to the several branches of the department, happen at present to be located near each other at Poona; and this circumstance has afforded a convenient opportunity for instituting an enquiry into the variations of procedure with a view to introducing greater uniformity, whenever this may be desirable for the promotion of general efficiency. Consequently, a Survey Committee was formed during the recess of 1881 at Poona, with instructions to report on the following subjects:—

I—The pay of the Native surveyors.
II—The systems of plane-tabling.
III—Improved topographical delineation.
IV—The rates of expenditure per square mile.
V—The local allowances given in the Bombay Presidency.
VI—Assimilation of the conventional symbols employed in the different parties.
VII—Assimilation of the forms of computation.
VIII—Assimilation of undesirable diversities of procedure.

Major Thuillier was appointed President of the Committee; the members were the officers who happened at the time to be holding executive charge of the respective parties.* Unfortunately Colonel Haig, the senior and most experienced of the officers serving with either of the five parties, who had for many years held charge of the Guzerat Survey, the most important of all, was absent, being employed at the time as Delegate for the Indian Government at the Venice Exhibition; but the reports submitted by the Committee are very valuable, and contain various useful suggestions for future consideration.

* Major Pullan, Trigonometrical.
Major Andrew, Revenue.
Major Lees Smith, Do.
Mr. J. McGill, Trigonometrical.
Brevet Lieutenant-Colonel Leach, V.C., Topographical.

6. Considerable attention has been devoted to improvements in the methods of hill drawing which are now practised in this Department. The hill-shading and the general orographical delineation are greatly hampered by the condition that the maps of all surveys made in this Department have for some time past had to be prepared in such a manner as to be suitable for immediate reproduction by photography, with a view to early publication. In former years all maps were lithographed, and as this entailed an entire re-drawing of the original by hand, either on stone, or on paper specially prepared for transfer to stone, a considerable interval—sometimes several years—was liable to elapse between the completion of a survey and the publication of the maps. At present publication may, and frequently does, follow the survey in a few days. But this great gain in time has been attended with a deterioration in the style and artistic finish of the maps, which was inevitable; for whereas formerly all hills could be drawn in brush work, with much delicacy of shade and mezzotint, and a variety of colours might be employed, if necessary, to indicate any features which it was desirable to distinguish prominently, and the lithographs moreover were generally superior to the original drawings,—at the present time the maps have to be drawn simply in pen and ink, without mezzotint, and entirely in a single colour, while the photozincographs are as a rule inferior in tone and delicacy to the original drawings, and they are also less clear and readily understood by the general public than are hand-drawn lithographs. Attempts have been made to improve the rendering of the hill-shading by the introduction of a scale of shade for horizontal hachures, with lines of prescribed thickness varying both with the slopes of the ground and the vertical intervals between the hachures, every line having a definite meaning, readily intelligible, and thus conveying more definite and precise information than can be derived from lines of shade drawn without system. But it has not been found an easy matter to determine a scale of shade which is suitable everywhere, and is generally accepted and approved even by the officers and surveyors who would have to carry it out. Much improvement is, however, being effected by increasing the number of determinations of height, so as to embrace points on low-lands and

flats and in valleys, as well as on hill peaks and prominent elevations. Thus more general and precise information of rise and fall and variations of level is afforded, and this information goes a long way towards making the maps more generally useful and compensating for deficiencies in toneless pen and ink delineations of the configuration of the ground.

7. The general out-turn of topography executed during the year in the course of the operations described in sections iv to xv of this report, has been as follows:—

6,016	square miles	surveyed on the	½	-inch scale.
6,610	ditto	ditto	1	„
10,073	ditto	ditto	2	„
76	ditto	ditto	4	„

Five towns and three cantonments, of an aggregate area of 61 square miles, have been surveyed on various scales ranging from 6 to 24 inches to the mile. Additional topography has been executed in connection with the mouzawari and cadastral surveys, described in sections xvii to xxiii, and in the course of the survey operations in Sikkim and around Darjeeling, section xxiv.

Mouzawar, Riverain and Forest Survey.

8. The Mouzawar or Village Survey, on the 4-inch scale, of the Dera Ismail Khan District has been continued, conjointly by the same party with the survey, by villages—also on the 4-inch scale—of the Kala Chitta Range in the Rawal Pindi District, which is being done for the Forest Department. The same party has also surveyed, during the recess season, seven hutted camps on the scale of 12 inches to a mile for the Military Department. The party employed on the topographical survey of the Meerut Division has continued the riverain survey of the Jumna.

The areas of these operations are—

2,464	square miles	surveyed on the	4	-inch scale.
4	„	„	12	„

9. A change of some importance, as regards the procedure to be adopted in future riverain surveys, has this year been introduced. The great rivers of India, whenever they pass through British territories, constitute natural boundaries between the principal districts; thus they have usually been mapped in the course of the surveys which are made in connection with the revenue and settlement operations of each district; and as these operations are invariably localised—having reference at the time only to the district in which they are actually being performed, and not being carried on continuously from one district into the next—the surveys also have hitherto been, as a rule, similarly localised. It thus happens that no complete survey of the riverain area, as it exists at any time, is made, for the survey only embraces one bank of the river, and as much as may be deemed desirable of the contiguous portions of the bed, *pari passu* with the settlement operations on this bank. The opposite bank is not mapped until the revenue and settlement survey of the district on that bank is undertaken, and an interval of several years may elapse between the two surveys. Meanwhile, the course of the river may change materially, lands may have been transferred from one bank to the other, and proprietors may have "followed their lands across the deep stream," which they are permitted to do by law. The two surveys of the riverain area, having been made at different times, are thus surveys of parts of which the sum does not necessarily equal the whole, either as regards individual properties or as regards the entire riverain area, as it existed at any time; thus the evidence they furnish as regards the facts of the riverain area is imperfect and insufficient for the purpose of indicating the extent of transfers of land from one bank to the other after changes in the course of the river. The Government of India has now ordered that "whenever a river happens to be under "survey professionally, the operations, though they may be immediately "required in connection with the settlement of a district on one bank of the "river, should be carried across to the opposite bank, and embrace the entire "area between the permanent lines of village boundaries on both banks. The "completion of the survey up to the permanent boundaries of the villages on "either bank obviously possesses administrative value, and is likely to facili-

"tate the more equitable adjudication of proprietary and tenant rights on the "banks of rivers which shift and change their courses in the rainy season."

10. Surveys have been called for to meet the requirements of the Forest Department in the Bombay Presidency as regards the large reserves in the Thana District. The Conservator reports that the 2-inch scale on which the maps of the topographical survey of the district are being drawn, is inadequate to represent all the features required to be shown on the forest maps, and the Government of Bombay has strongly urged the necessity for increasing the scale to that of 4 inches to the mile, for the Forest reserves. But it appears that these reserves are so much intermingled with the village lands that it would not be expedient to survey them on a different scale from the rest of the district; the 4-inch scale will therefore be uniformly adopted for next year's operations in the Thana District.

11. In British Burma there has also been a demand for maps of forest reserves; it will be met, in the case of the reserves falling within the districts under cadastral survey, by employing small detachments from the cadastral parties, to carry on 4-inch topographical surveys of the reserves, simultaneously with the 16-inch surveys of the cultivated tracts. By the special request of the Chief Commissioner, Burmans will be employed on these forest surveys, as far as may be possible, when a sufficient number have received the necessary training; the attention of the surveyors of the cadastral detachments during next season will be largely devoted to the instruction of the Burman apprentices.

Cadastral Survey.

12. The Cadastral Surveys of Districts Jaunpur, Ghazipur, and Mirzapur of the North-West Provinces, and of Districts Hanthawaddy and Bassein in British Burma on the 16-inch scale, have been continued, Jaunpur having been completed during the season. A new party has commenced cadastral operations, also on the 16-inch scale in the Tharawaddy District of British Burma.

The areas surveyed by the cadastral parties by provinces are:—

	Square Miles.
In North-West Provinces	1,742
„ British Burma	1,931
TOTAL	3,673

Preliminary traversing for the cadastral surveys of next season has been done over 1,926 square miles. A small detachment of surveyors has been employed in surveying the boundaries of waste land grants in the Arakan Division of British Burma.

13. In the Cadastral Surveys of British Burma the Natives of the country have been freely employed as field surveyors and draftsmen, and have continued to give great satisfaction. Hindustanis have still to be employed in the more responsible posts, and they still form the greater part of the field establishments, but their places are being gradually taken by Burmans, and the officers in charge of the parties will probably be able to dispense with more of their Hindustanis, when they or their European assistants acquire a better knowledge of the Burmese language. Many Burmans join the parties to get instruction in field surveying, and thus to qualify for appointments as "Thoogyees" (Revenue Collectors), or for employment in the civil establishment, which will be required to introduce the changes in the fields on the printed maps as they occur from time to time. The officers in charge of the survey parties have loyally furthered the wishes of the Chief Commissioner in respect of these men, and have readily given up, for employment elsewhere, men it has cost them no small trouble to train and who as yet have done them no service, knowing that they will have to replace them by others quite untrained and equally liable to be removed as soon as they become efficient. All measurers and instrument-carriers required for the Burma parties have still to be sent for from India, they are sent across to Rangoon at the commencement of the field season and brought back again to Calcutta at its close; being over 2,500 in number, the arrangements for engaging their services and transporting

them to and from Burma, at a minimum cost to Government, involve much care and responsibility.

Military Reconnaissance and Geography.

14. The operations of Military Reconnaissance and Geographical Survey across the British frontier have been carried on wherever practicable. The withdrawal of the British forces from Kabul and Jellalabad in September 1880 put a stop to the further prosecution of survey operations in Northern Afghanistan generally; but advantage was taken of the expedition into the country of the Mahsud Waziris in the spring of 1881 to make additions to the surveys which were executed during the expedition of 1860; thus, all the gaps in the first survey were filled in, and a considerable area of country, hitherto entirely unknown, lying to the west towards Kandahar and Ghuzni, was sketched from the high mountain peaks on the western border of Waziristan. The Zhob valley was also reconnoitred by a Native explorer. In Southern Afghanistan some additional topography was obtained as the British forces were not withdrawn from Kandahar until April 1881. A large scale survey of Kandahar and the surrounding country was made: surveys were effected in the Khakrez valley, and towards the Hazara country; and the general triangulation was extended and connected with the corresponding operations from the south.

15. In Beluchistan an area of 3,500 square miles has been surveyed on the $\frac{1}{2}$-inch scale, and a further area of about 2,800 square miles has been reconnoitred on the $\frac{1}{4}$-inch scale in and around the Marri Hills.

Venice Geographical Exhibition.

16. In January 1881 the Consul General of the King of Italy invited the Government of India to take part in the International Geographical Congress and Exhibition which took place at Venice in the latter half of the present year. The Surveyor-General was requested to send contributions from the Survey of India to the Exhibition. In accordance with these instructions the following articles were forwarded:—A collection of maps illustrative of the Geography and Surveys of India; specimens of styles of reproduction and publication in the Surveyor-General's Offices, including engraving, lithography, chromo-printing, photozincography, and photocollotype; specimens of Trigonometrical, topographical and Revenue Survey maps and charts; the annual reports and the reports of Trans-Himalayan explorations; the professional and the synoptical volumes of the Great Trigonometrical Survey; also a complete set of instruments representative of those generally employed in the principal triangulation, and in the topographical, cadastral, spirit-leveling and tidal operations, with labels attached descriptive of their character and performances.

17. General Sir Henry Thuillier, C. S. I, the late Surveyor-General, and two of the Officers of this Survey, Colonel Haig and Captain Baird, were deputed by the Secretary of State and the Government of India to represent the British and the Indian Governments at the Congress and Exhibition. Colonel Haig has submitted a report of the duties he performed conjointly with General Sir Henry Thuillier and Captain Baird, extracts of which are given in the appendix. The exhibition appears to have been considered a success as regards the contributions from this Department; the Secretary of State and the Government of India have already expressed approval thereof.

PART I.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE SURVEY DEPARTMENT.

TRIANGULATION.

I.—THE EASTERN SIND SERIES.

18. This series of triangles, the last of the principal chains remaining for completion in Western India, was commenced in the field season of 1875-76 by Captain (now Major) Rogers. During the years 1877-79 operations were suspended, first, because the failure of the rains in 1877 deprived the country of its natural water-supply, and afterwards because Major Rogers' services were required with the army in Southern Afghanistan, his assistants being employed at the same time in minor triangulation in Beluchistan. The party was reassembled in Sind during the field season of 1879-80; the operations on the principal series were then resumed, and the final observations were brought up to a point which left just sufficient triangulation for the completion of the principal and the minor collateral chains to be performed in a single field season. This work has now been accomplished by Colonel Branfill with the aid of a single European Assistant, Mr. Torrens.

Personnel.

Lieutenant-Colonel B. R. Branfill, Deputy Superintendent, 2nd grade.
Mr. C. P. Torrens, Assistant Surveyor, 1st grade.

19. Colonel Branfill—having finished the principal triangulation in Southern India, as set forth in section I of the report for last year, and broken up the Madras party, of which he had been in charge—proceeded from Bangalore to Sind, where, on the 6th November, he assumed charge of the Bombay party, formerly under Major Rogers. It had been equipped for the field by Mr. Hennessey, who had held temporary charge, in addition to his other duties, since Major Rogers' departure on furlough to Europe in April.

20. The operations lay in the belt of country on either side of the meridian of 74½, between the parallels of 27° 38′ and 28° 20′. The southern portion was desert, pure and simple, water having to be carried on camels for many miles to each station. Then, as the boundary between the Bhawulpur desert and the valley of the Indus was approached, hills and long ridges of drift sand were met with, divided by, or interspersed with, stretches of low-lying alluvial flats, which are mostly dependent on rain-fall for their supply of water, and are thus practically desert for the greater portion of the year: when rain does fall, grass and shrubs spring up and render these tracts good grazing-ground for cattle and camels for a short time afterwards; to some of them the flood waters of the Indus find occasional access by the old river channels, the deeper parts of which contain water for some months after the subsidence of the annual inundation, and are thus natural reservoirs; they are locally called 'dhandhs.' Finally, the valley of the Indus was entered, and the principal operations were brought to a close on two stations—Dáowála and Máchka—of the Great Indus Series, which had been established in the year 1859-60; this part of the country was covered with a dense growth of acacias and other trees, the clearance of the necessary rays through which was tedious and laborious.

21. The triangulation had already been designed and laid out so as to form a hexagon, a quadrilateral and two pentagonal figures. Half the stations had been built; but three towers and as many platform stations had still to be constructed, and 140 miles of line had to be cleared on the rays between the principal stations. The ray on the side of origin—between the stations of Chauki and Trisingh—was found to have become blocked up by a moving sand-hill during the interval of six months which had elapsed since the stations were last visited; but Major Rogers had fortunately anticipated that this might happen, and had taken observations at both the base stations

to the forward station at the vertex of the first triangle; thus, it only remained to measure the third angle, and the necessity of clearing a ray through the sand-hill was avoided. The terminal stations in the valley of the Indus—towers about 24 feet high—were found still serviceable; but they had both become deflected to some extent; thus it was necessary to enlarge the upper portions of the central shafts before the large theodolite could be plumbed over the markstone at the ground level.

22. The observations of the principal angles were satisfactorily completed in about 2½ months, together with astronomical observations at two of the principal stations for the determination of azimuths of verification. The triangulation spanned a distance of about 50 miles in a direct line, introducing 13 new stations, and covering an area of 733 square miles. The vertical angles were observed with some trouble owing to variations in atmospheric conditions materially influencing the terrestrial refraction, which in several cases was found to be negative, to an average extent of an eighth of the contained arc, thus making signals at a distance of 10 miles appear to be as much as 14 feet below their actual position. The instrument employed in the measurement of the principal angles, both horizontal and vertical, was Troughton and Simm's 24-inch theodolite No. 1, which had been recently brought up from the triangulation of the Madras Presidency.

23. As a part of the operations of this (meridional) series, it had been previously determined to carry a longitudinal chain of secondary triangles across Central Sind, to Sehwán, to furnish points for the topographical and revenue surveys in a tract which was devoid of triangles. The ground to be traversed had been reconnoitred last year, when sites for most of the stations were selected. This year the remaining stations—with others which were required to carry the chain over a distance of about 30 miles to the west of Sehwán, to effect a junction with the Great Indus Series—were selected; the whole of the angles were measured by Mr. Torrens during the latter half of the field season, after the completion of the preparatory operations on the principal series. The chain consists of 32 triangles, extending over a direct distance of 154 miles, and covering an area of 1,564 square miles; all the angles were observed with a 10-inch theodolite to heliotrope signals; 14 points, including 7 revenue survey stations, were fixed collaterally. In the valley of the Indus, ray clearing was found necessary here as on the principal series, lines of an aggregate length of 35 miles having to be cleared. At four stations additional height, which was wanted both for the observer and the signals, was afforded by erecting a braced tripod stand, 16 feet high, of rough timber, for the theodolite, and around it a separate scaffolding for the observer and signallers. Mr. Torrens has accomplished an excellent out-turn of work, and Colonel Branfill reports that the computations show that the quality of the work is not inferior to the quantity, the closing errors at the junction with the Great Indus Series being very minute.

II.—THE EASTERN FRONTIER SERIES.

24. The programme of operations for the field season was to extend the principal triangulation from Tavoy southwards as far as practicable, and to select a site for the measurement of a base line of verification somewhere in the Tenasserim District. Also to utilize the opportunity afforded by the retention of one of the surveyors in Siam after the completion of the chain of triangles to Bangkok, previously reported on, to execute as much secondary triangulation in Siam as could be conveniently accomplished.

Personnel.

Captain J. Hill, R. E., Officiating Deputy Superintendent, 3rd grade.
Mr. L. J. Pocock, Surveyor, 4th grade.
„ C. D. Potter, Assistant Surveyor, 1st grade.
„ J. F. McCarthy, Assistant Surveyor, 2nd grade.

25. The selection of a suitable site for the measurement of a base line was a matter of considerable importance; for both the mainland and the islands on the coast were known to be covered with a more or less dense growth of forest, such as ordinarily necessitates both line-cutting and tower-building as a preliminary for the triangulation; and it was known that the amount of labour available on the spot, in almost all parts of Tenasserim, was inadequate for much work of this nature, which therefore could only be performed by the

importation of labourers and masons from India at an almost prohibitory cost. A site which had been selected in the previous year, in the Island of Yaykhyo-doungkym, was found very objectionable for these reasons. But this year a much better site was fortunately discovered, in the neighbourhood of the villages of Townghpecla and Toung Byai in the Pagot Toung circle of the Mergui Township, affording a line of about 3 miles in length, which escapes all obstacles, runs between hills tangentially to their bases, and is beyond the range of the numerous creeks which penetrate inland from the sea; it is thus well adapted for measurement. Hills were met with on the prolongation of this line to the north and south, and other hills on both flanks, which would serve for the extension of the measured section by supplemental triangulation. Last, but not least, provisions for the considerable number of surveyors required to carry out the measurement and the collateral operations would be easily procurable.

26. The selection and preparation of the base line, and the construction of tower stations at its extremities on the plain, and platform stations on the surrounding hills for the extension-triangulation, occupied a portion of the party under Mr. Pocock for the whole of the field season, and necessitated periodical visits of inspection by Captain Hill. That officer however was chiefly engaged on the principal triangulation. He took observations at seven stations, but unfortunately was greatly hindered by the condition of the atmosphere, which happened to be exceptionally hazy and unfavourable for the observation of distant objects. Thus, though Captain Hill succeeded in completing almost all the angles of the triangulation between Tavoy and the base line, and in connecting his heights with the sea-level for verification, he was obliged to leave a few angles unmeasured, as the atmosphere never cleared sufficiently to enable him to get a sight of the signals at the extremities of his longest rays. He reports that the haze was so dense that—

"in addition to stopping our observing it caused considerable inconvenience to shipping people and to the fishing population, the latter not venturing out until they can see from one island to the next. * * * The existing meteorological records do not furnish us with any means of making a forecast at the beginning of a field season as to the kind of weather to be expected. The most we have learned by experience appears to be that haze generally commences about the middle of January, when the weather begins to get warm, and varies in intensity very much in different years, and that rain does not seem to have any effect upon it. It appears to depend on the direction of the wind. With the north-east or easterly winds which prevail during the field season, the weather, after the middle of January, ceases to be clear. On the other hand, when the wind veers (as it generally does about three times between the middle of January and the beginning of April), and blows from the south-west or west, the air clears. The Natives corroborate our experience in this respect, and say in addition that exceptionally hazy seasons occur at intervals of about five or six years."

27. Mr. Potter was chiefly employed in selecting and constructing the principal stations around the base line, and clearing the rays between them. He then endeavoured to effect a southerly extension of the series towards St. Matthew's Island, or some other point near the extremity of the British territories on the Malayan Peninsula. But in this he also was baffled by the hazy condition of the atmosphere, for though he exerted himself greatly, travelled considerable distances and ascended many hills, he was only able te see very little of the country, and could not complete his reconnaissance.

28. It had been necessary, with a view to the completion of the triangulation to Bangkok, to leave Mr. McCarthy in Siam during the recess of 1880. Thus, at the commencement of the survey year under review he was in Siam, where he still had some work to complete. The triangulation had been extended collaterally so as to determine a large number of points; it embraced altogether an area of about 8,000 square miles, including hill peaks on both sides of the head of the Gulf of Siam. The City of Bangkok had also been mapped, on the scale of 4 inches to the mile, and compass sketches of the chief rivers and canals within the limits of the triangulation had been made. Mr. McCarthy was about to return to British territory, when he was requested by Mr. Newman, Vice-Consul in charge of the British Agency at Bangkok, to accompany a Siamese telegraphic expedition which was then about to start for Natyadoung, a pass on the British frontier about 55 miles to the north of the Amya Pass, by which Captain Hill had entered Siam. He did so, and availed himself of the opportunity to execute—with the assistance of the Siamese

officials—a survey of the line of route with a magnetic compass and some cane ropes, checking his work by taking the bearings of surrounding peaks previously fixed by the triangulation. He also measured the discharge of the united streams Khuai-Nai and Khuai-Yai opposite the town of Kanburi, and that of the River Amya, at a point where he was encamped on his return march. Latterly his operations were much retarded by the atmospheric haze, which at the same time was found such a hindrance in the observation of the principal angles and in the laying out of the triangulation to the south.

29. The experience of this and other years has shown that favourable atmospheric conditions for carrying on a triangulation are usually met with in this region during the months immediately succeeding the rainy season, that is to say from October to January, after which a long period of hazy weather sets in, when all objects distant more than a few miles are entirely shut out from view. Arrangements have therefore been made to guard against a recurrence of retardation in the operations of next season from the same cause, by devoting the first half of the season to the triangulation and the second half to the measurement of the base line at Mergui. The Government steamer *Celerity* has been placed at the disposal of the surveyors for the three first months of the season, to enable them to move about with greater rapidity and be no longer dependent, as hitherto, on the sailing vessels which are ordinarily employed by the Natives of the country in their coasting voyages.*

III.—THE SECONDARY TRIANGULATION IN BURMA.

30. The chain of secondary triangles known as the Cape Negrais Series, which branches out of the Eastern Frontier Series in the Henzada District, required strengthening and amplification, having been left incomplete during the previous year. Captain Hill deputed Moung Shoay Gyoke to execute this work: this surveyor is a native of Burma who had originally been entertained as a clerk in the Burma Party, and was afterwards taught the use of the theodolite by Mr. W. Beverley, and has proved himself to be a good observer and a very useful and trustworthy man. In the present instance he showed much intelligence and skill in surmounting difficulties, clearing rays through forest whenever unavoidable, and erecting lofty tripod stands for his instrument—a 12-inch theodolite—with corresponding scaffoldings for supporting the observer at the height of the instrument, and a signaller 15 feet above. Captain Hill reports that "he has done remarkably well, and has shown that he can be employed advantageously on independent work."

TOPOGRAPHY.

IV.—GWALIOR AND CENTRAL INDIA SURVEY (No. 1 TOPOGRAPHICAL PARTY).

Personnel.

Major C. Strahan, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. W. J. Cornelius, Assistant Surveyor, 1st grade.
" P. J. W. Dornn, " " 1st "
" C. T. Templeton, " " 2nd "
" A. Kitchen, " " 2nd "
" G. P. Tate, " " 3rd "
Sub-Surveyor, Mr. J. R. Harris.
" " J. Nathaniel.
" Abdul Aziz.
" Badri Dutt.
" Jafir Ali.

31. The triangulation carried on in previous seasons by this party having been more than sufficient for the immediate requirements of the detail surveyors, none was undertaken during this year, with the exception of a few observations for the trigonometrical determination of points for the basis of a large scale survey of the Cantonment of Kotra.

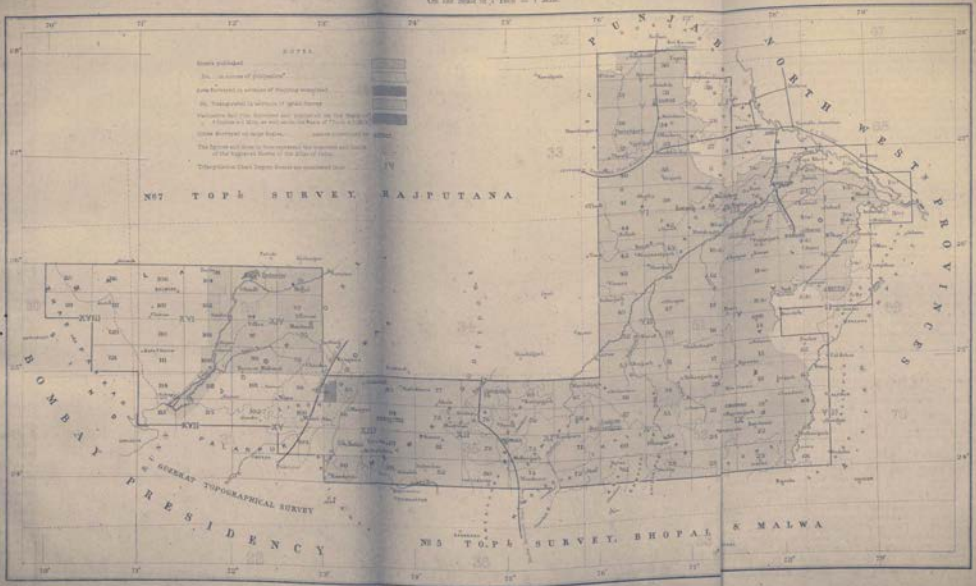
32. The detail survey on the scale of 1 inch equal to 1 mile was extended over the country in the immediate vicinity of Kotra and between Oodeypore and Sirohi, represented on the index maps by Sheets 85, 86, and 89. It included portions of the States of Mewar, Sirohi and Idar, and covered an area of 1,217 square miles. Major Strahan reports that, with the exception of a few square miles in the north-western portion of the work, the whole of this tract presented a mass of intricate detail, covered with dense grass and tree jungle.

* Captain Hill reports most favourably of the performances of each of his three assistants—Messrs. Pocock Potter, and McCarthy.

No. 1 PARTY.

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY.

On the Scale of 1 Inch = 1 Mile.



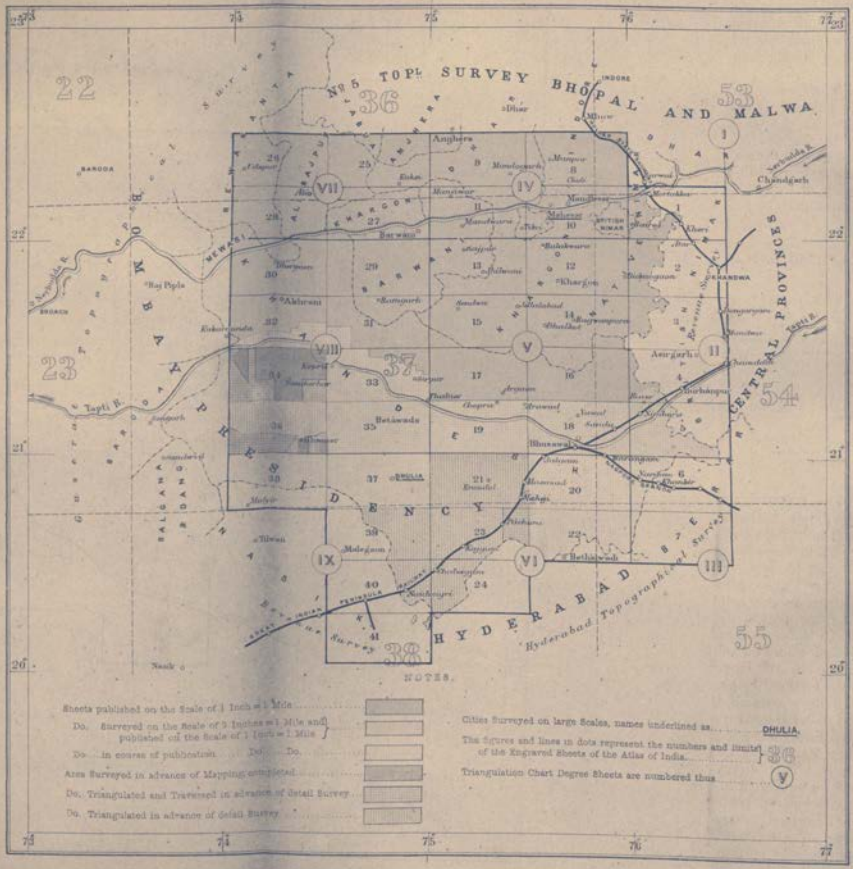
Published under the direction of Lieut.-General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

At the Surveyor General's Office, Calcutta, September 1861.

No. 2 PARTY.

INDEX TO THE SHEETS OF THE KHANDESH & BOMBAY NATIVE STATES TOPOGRAPHICAL SURVEY.

On the Scales of 1 Inch = 1 Mile and 2 Inches = 1 Mile.


No 5 TOPL SURVEY
BHOPAL AND MALWA
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Amjhera
Mandsaur
Malsowr
Neemuch
Chandgarh
Aseergarh
Betawada
Bhuswal
Bethiawah
Nasik
Indore
Dhar
Baroda
Broach
Rajpipla
Akleswar
Rampurah
Sendwa
Khargone
Barwani
Sirpur
Chopra
Jamner
Chalisgaon
Nandurbar
Sindkheda
Dhulia
Malegaon
Dharangaon
Yawal
Raver
Burhanpur
Khandwa
Harsood
Hoshangabad
Sohagpur
Betul
Multai
Ellichpur
Amraoti
Akola
Wun
Pusad
Kinwat
Nanded
Parbhani
Jintur
Aurangabad
Ahmednagar
Poona
Satara
Sholapur
Bijapur
Belgaum
Kolhapur
Ratnagiri
Panjim
Goa
Karwar
Sirsi
Hubli
Dharwar
Gadag
Bagalkot
Kaladgi
Hyderabad
Tapti R.
Purna R.
Godavari R.
Wainganga R.
Wardha R.
Penganga R.
Manjra R.
Bhima R.
Krishna R.
Tungabhadra R.
Malprabha R.
Ghataprabha R.
Warna R.
Panchganga R.
Kistna R.
Narmada R.
Mahi R.
Sabarmati R.
Mewas
Gaikwar's Territory
Portuguese Territory
Sawantwadi
Kolhapur
Jath
Sangli
Miraj
Kurundwad
Ichalkaranji
Kagal
Mudhol
Ramdurg
Nargund
Navalgund
Kundgol
Hangal
Savanur
Shiggaon
Ranebennur
Haveri
Hirekerur
Byadgi
Kod
Kalghatgi
Hubli
Dharwar
Gadag
Bagalkot
Kaladgi
Badami
Ilkal
Hungund

33. In carrying on work near the borders of the three States above-mentioned, considerable tact and judgment was necessary. When the attitude of the Bhils in one State became somewhat threatening, the surveyor had to move his camp without delay into the neighbouring State, returning when he thought the temporary excitement had subsided. On one occasion an Assistant Surveyor and his party were surrounded, the Assistant Surveyor was hustled off into the centre of the pâl by a number of men with drawn swords and bows and arrows, and only released at the intervention of the women: one friendly old woman warning the party that if they came back they would peril their lives.

34. The Cantonment of Kotra was surveyed on the scale of 8 inches equal to 1 mile. This survey covered an area of 3·03 square miles and will furnish a map in one sheet.

35. During the current season this party will extend the triangulation over about 1,650 square miles of country, represented on the index map by Sheets 99, 100, and 103, between Erinpura and Palhanpur, and the detail survey on the scale of 1 inch equal to 1 mile will be continued in the tract represented on the index map by Sheets 85, 91, 92, 95, and 96.*

V.—KHANDESH AND BOMBAY NATIVE STATES SURVEY (No. 2 TOPOGRAPHICAL PARTY).

36. This party continued the survey on the scale of 2 inches equal to 1 mile of the Khandesh District and made a survey on the scale of 8 inches equal to 1 mile of the town and station of Dhulia.

Personnel.

Mr. J. McGill, Officiating Assistant Superintendent, 1st grade, in charge.
Mr. A. G. Wyatt, Surveyor, 4th grade.
„ J. A. Barker, Assistant Surveyor, 1st grade.
„ F. E. Warde, „ „ 1st „
„ G. Vanderbeck, „ „ 2nd „
„ E. Graham, „ „ 2nd „
„ C. George, „ „ 3rd „
Sub-Surveyor, Sheikh Omer.
„ Mr. F. Rozario.
„ Hyder Ally.
and four others.

37. The triangulation this year extended over an area of 1,699 square miles in the talukas of Dhulia, Pachora, Erandol, and Chalisgaon. Mr. Graham was entrusted with the execution of this work, with the exception of 69 miles undertaken by Mr. McGill, which completes the triangulation required for this survey.

38. The traverses which are made for the purpose of fixing the tri-junctions of villages with the object of assisting the settlement officers, and of enabling the village boundaries to be transferred from the Bombay Revenue Survey village maps to those of this survey, were carried on in the talukas of Nasirabad, Erandol, Jamner, and Pachora (Standard Sheets 20 and 22), and in the Talukas Dhulia, Amalner, and Pimpalner (Standard Sheet 37). 510 linear miles of traverses were completed, fixing 483 tri-junctions. While these traverses are being made, part of the duty of the traverse surveyor is to note all the topographical features, such as streams, roads, &c., which fall on his line. These, when plotted, afford an additional check on the work of the detail surveyors.

39. The detail survey was carried on in the Talukas of Bhusawal, Nasirabad, Jamner, Erandol, and Pachora (Standard Sheets 5, 6, 7, 20, 22, and 37) with a large overlap in the Nizam's territory. The area thus surveyed amounted to 1,493 square miles checked by careful examinations on the ground and by 261 linear miles of partal survey exclusive of the checks afforded by the traverses. A survey of the town of Dhulia was made on the scale of 8 inches to the mile. This survey covered an area of 10·5 square miles, the map of which will be published in one sheet.

40. The eastern portion of the country over which the detail survey was carried is described as undulating, with low hill ranges, scattered here and there, none of which attain a height of more than 300 feet above the plains. The south-western portion is described as flat, with rich black soil, and well studded with large trees. The Walwari plateau passes through the centre of the country triangulated, terminating on the eastern side in steep and sometimes abrupt slopes. The Adjunta hills and Satmala ranges lie to the south, their peaks rising to heights varying from 1,200 to 2,700 feet.

* Major Strahan highly commends the work of Mr. Cornelius, and reports very favourably on that of his other European Subordinates.

41. The area surveyed by this party up to the end of the last field season now amounts to 15,156 square miles, and the area remaining for survey is estimated at 2,650 square miles, inclusive of overlaps and outlying villages.

42. During the current season the detail survey will be carried on in Sheets 21, 23, and 34, and steps will be taken to connect a few outlying villages situated in the Nasik Collectorate with the rest of the survey of the Khandesh District.*

VI.—BHOPAL AND MALWA SURVEY (No. 5 TOPOGRAPHICAL PARTY).

43. This topographical party carried out the programme referred to in para. 41 of last year's report, *viz.*, extended the triangulation to the extreme limits of the ground shown on the index map by Sheets 49 and 51, covering an area of 273 square miles, and completed the detail survey on the scale of 1 inch equal to 1 mile of the ground shown by Sheets Nos. 38, 40, and 55; an area of 1,460 square miles was plane-tabled, of which about 400 consisted of very hilly and intricate country, covered with jungle inhabited by the Bhils, while the remainder of the ground was more or less easy for the Surveyors.

Personnel.

Major J. R. Wilmer, Officiating Assistant Superintendent, 1st grade, in charge.
Mr. D. Atkinson, Surveyor, 2nd grade.
„ C. F. Hamer, „ 4th „
„ E. A. Wainright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen, „ „ „ „
„ W. H. Lilley, „ „ „ „
„ G. R. Copping, „ „ 3rd „
Sub-Surveyor, Prem Raj.
„ Harlal Sing.
„ Kristodhan Chatterji.
„ Gobardhan Das.
„ Shib Charan.

44. The cities of Ujain, Rutlam, and Jhabua were surveyed and mapped on the scale of 6 inches equal to 1 mile. The plan of Ujain in two sheets covers an area of 18·0 square miles, that of Rutlam in one sheet 7·3 square miles, and that of Jhabua in one sheet 7·1 square miles.

45. This party has surveyed an area of 24,302 square miles, since it commenced work in Bhopal in the year 1870, and an area of about 4,240 square miles remain to be surveyed.

46. During the current season the triangulation will be extended over the tract falling in Sheets 50 and 52, and the detail survey over the country shown in the index map by Sheets 51 and 53.†

VII.—SYLHET, KHASI, AND GARO HILLS SURVEY (No. 6 TOPOGRAPHICAL PARTY).

47. The officer in charge of this party again experienced great difficulty in procuring a sufficient number of Khasia coolies to enable the whole party to be started for field work as early as would have been desirable. Some detachments left Shillong on the 16th November, but the last could not leave till very late in December, and in consequence the duration of the field season, always unavoidably short in that country owing to heavy falls of rain which generally takes place in March, was curtailed below its normal period.

Personnel.

Major W. F. Badgley, S. C., Deputy Superintendent, 3rd grade, in charge.
Mr. M. J. Ogle, Surveyor, 4th grade.
„ A. W. Cheunel, „ 4th „
„ J. McCay, Assistant Surveyor, 2nd grade.
„ P. White, „ „ 2nd „
„ D. Campbell „ „ 3rd „
Sub-Surveyors,—Moonshi Shah Nasirudin and one other.

48. The triangulation during the previous season having been extended over a larger tract of country than could possibly be surveyed during the season under report, none was needed during this season, and the labours of the whole party were devoted to the detail survey. The survey on the scale of 2 inches to the mile covered an area of 151·5 square miles situated on the west side of the Lungai River, and south of Aditmahal in the southern portion of the Sylhet District. The tract surveyed on the scale of $\frac{1}{2}$ inch equal to 1 mile, in area 192·7 square miles, lies immediately to the south of the above, extending into Hill Tipperah, with its western limit about 6 miles east of Koilashar. One of the Native subordinates of the party surveyed 36·9 linear miles of estate boundaries.

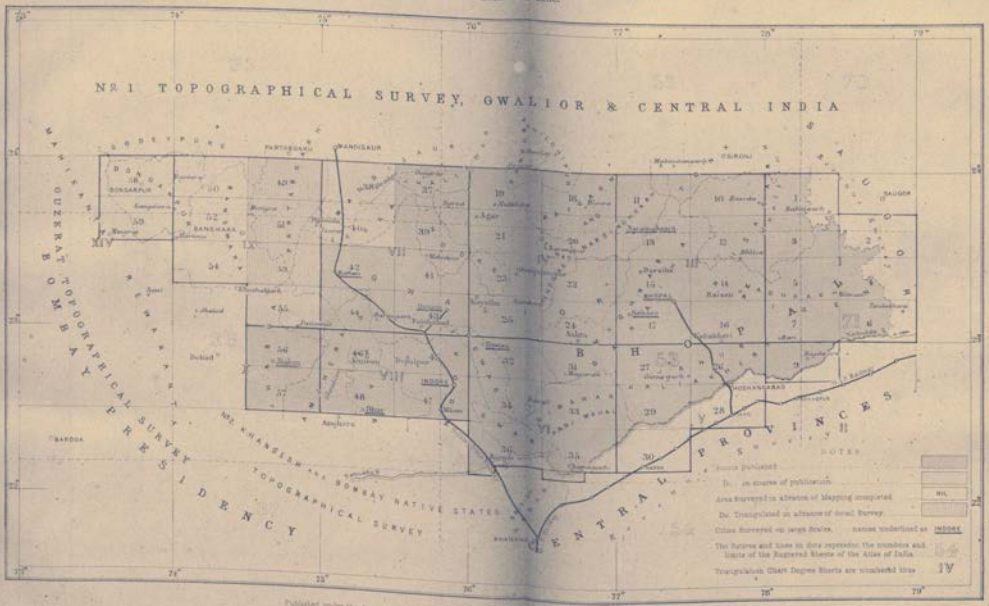
* Mr. McGill highly commends the work of Messrs. Wyatt, Warde and Graham, also that of Sub-Surveyor Sheikh Omer, and reports that Messrs. Barker, Vanderbeck, and George, and Sub-Surveyors Rozario, Bapu Jadu, Sheikh Mohadeen, worked steadily and well.

† Major Wilmer reports approvingly of all his assistants.

No. 5 PARTY.

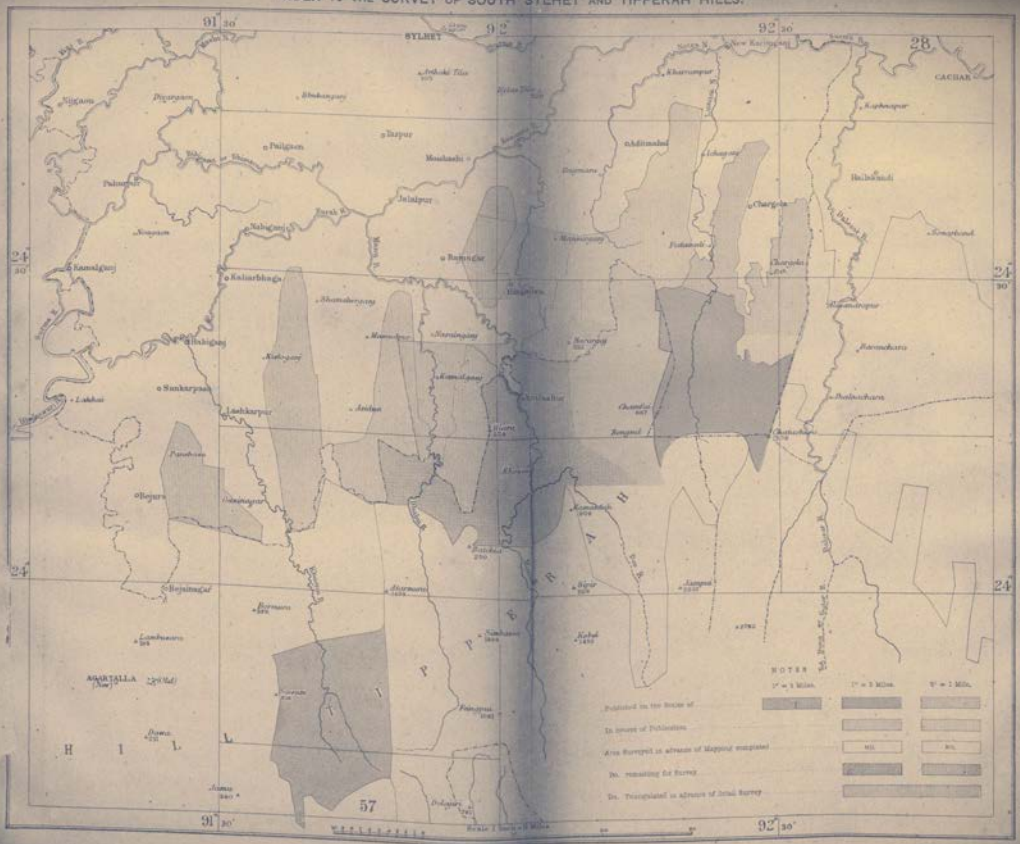
INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.


No. 1 TOPOGRAPHICAL SURVEY, GWALIOR & CENTRAL INDIA
GUJERAT TOPOGRAPHICAL SURVEY
BOMBAY PRESIDENCY
NO. KHANDESH & BOMBAY NATIVE STATES TOPOGRAPHICAL SURVEY
CENTRAL PROVINCES
BERAR
NOTES
Sheets published
Do. in course of publication
Area Surveyed in advance of Mapping completed
Do. Triangulated in advance of detail Survey
Cities Surveyed on large Scales, names underlined as INDORE
The Scales and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India.
Triangulation Chart Degree Sheets are numbered thus IV

Published under the direction of Lieut.-General J. T. Walker, C.B., R.A., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, November 1881.

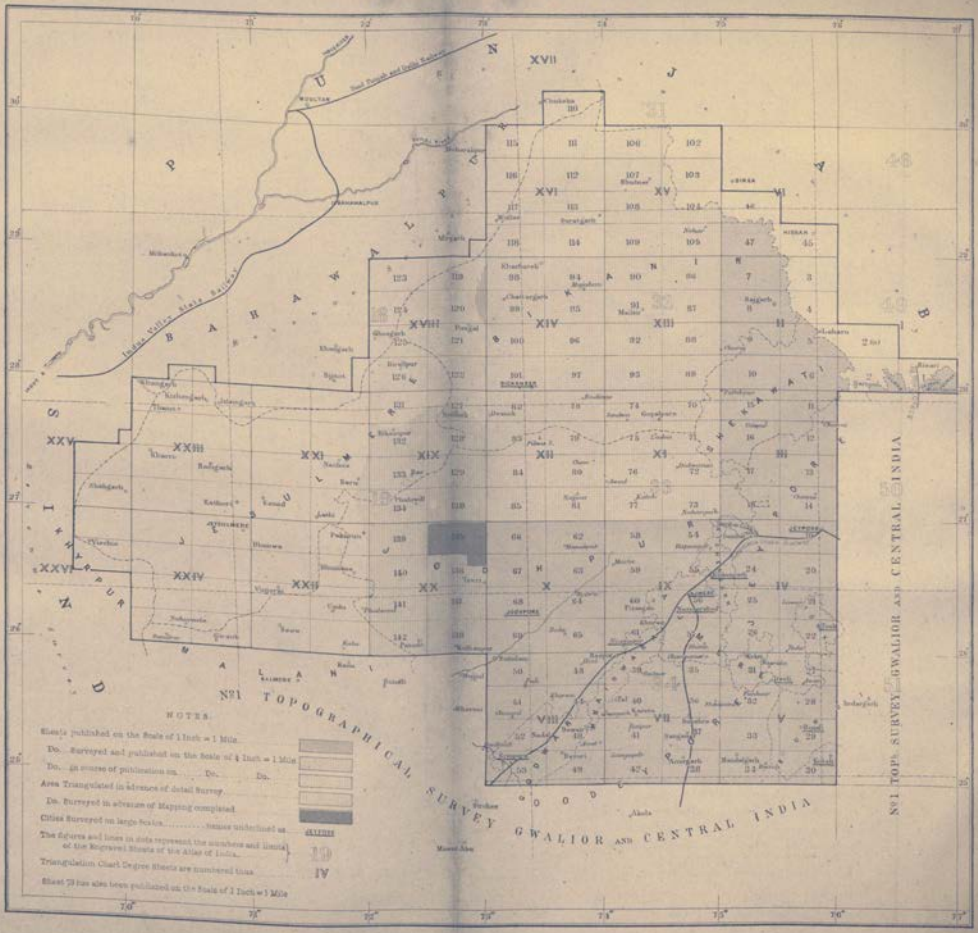
INDEX TO THE SURVEY OF SOUTH SYLHET AND TIPPERAH HILLS.


91° 30'
92°
92° 30'
24° 30'
24°
SYLHET
CACHAR
Nilgaon
Dingapur
Paligaon
Jaypur
Mouhashi
Palonia
Jalalpur
Nabiganj
Ranaghat
Kamalganj
Kaliarbhaga
Shamshergong
Sunamganj
Sankarpasa
Lakhai
Lashkarpur
Amlaut
Bajura
Jaintiapur
Burmuria
Lumbasura
Ambaria
Kharkhai
Kharkhai
Jhanjira
Chargola
Kalinagar
Kamalpur
Ramchandrapur
Ramchandrapur
Ratnachandrapur
Ratnachandrapur
Kamalpur
Langma
Kalapahar
Kalapahar
Kalapahar

No. 7 PARTY.

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY,

On the Scales of 1 Inch = 1 Mile and ½ Inch = 1 Mile.



Published under the direction of Lieut.-General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India,
at the Surveyor General's Office, Calcutta, Nov. 1861.

49. During the recess season the survey of the station of Shillong on the scale of 24 inches to the mile was very nearly brought to a close. Major Badgley reports that if the rainfall had been less continuous the out-of-door work for this survey, which has now been extended over several recess seasons, would have been finished.

50. As the cost of that portion of the work which is surveyed on the scale of 2 inches to the mile is very great, reference was made to the Chief Commissioner of Assam with the object of ascertaining the views of the Local Government as to the propriety of reducing the scale of survey. The Chief Commissioner having given his opinion that the survey on the 2-inch scale should be continued, instructions to that effect were sent to the officer in charge of the party.

51. The area remaining for survey in this district is as follows:—

For survey on the scale of 2 inches = 1 mile about 285 square miles.
" " ½ inch = 1 mile " 420 " "

Major Badgley reports that the country remaining for survey presents fewer difficulties than that surveyed during the last three years, and as some more Native sub-surveyors have been attached to the party, a more rapid progress may be expected.

52. During the ensuing season Major Badgley, who has so long held charge of this party, will be employed on the survey of the boundary between Burma and Munipur. He will be assisted by Mr. Ogle. Brevet-Lieutenant-Colonel R. G. Woodthorpe, who returned from furlough to Europe in October 1881, will have charge of the party.*

VIII.—THE RAJPUTANA AND SIMLA SURVEYS (No. 7 TOPOGRAPHICAL PARTY).

Personnel.

Brevet-Colonel G. C. DePrée, S. C., Deputy Superintendent, 1st grade, in charge.
Mr. G. A. McGill, Surveyor, 2nd grade.
Mr. E. S. P. Atkinson, Surveyor, 4th grade.
Mr. J. H. Wilson, Assistant Surveyor, 1st grade.
Mr. W. C. G. Barckley, " " 2nd "
Mr. R. W. Senior, " " 3rd "
Sub-Surveyor Modhusudan Dutt.
" Munshi Esuf Sharif.
and 5 others.

53. This party was employed partly in Rajputana and partly in the neighbourhood of Simla, in accordance with the programme set forth in paragraph 49 of the general report for last year.

54. The triangulation in Rajputana was extended over an area of 4,500 square miles by Mr. G. A. McGill, covering the country shown on the index map by the western portion of degree sheet XX and the greater portion of degree sheet XIX. The detail survey in Rajputana, on the scale of ½ inch equal to 1 mile was carried on in the northern portion of degree sheet XV, in degree sheet XVI and in the north-west portion of degree sheet XIX, and covered an area of 5,010 square miles in a very flat, sandy country, more or less studded with sand-hills, of very slight elevation in the portion bordering on Bahawalpur, and not very prominent in the other portions. Colonel DePree describes the country as in character more nearly approaching that of a desert than any he had previously traversed.

55. At the request of His Excellency the Commander-in-Chief, a survey was made on the scale of 6 inches equal to 1 mile, of the cholera camp near Kasauli, with the adjacent ground to an average distance of about one mile on either side of the ground occupied by the camp. This survey embraced an area of 6,912 acres.

56. In addition to this an area of 2,018 acres, distributed as follows, *viz.*, 1,129 acres in the Cantonment of Dagshai, 441 acres in Solon, and 448 acres in Jutogh, was surveyed on the scale of 24 inches equal to 1 mile. The re-survey of the Cantonment of Jutogh was necessitated by the large extension of building operations in that locality subsequent to the year 1874, when the former survey was completed.

57. The results of this season's work will furnish the material for publishing the maps on the ½-inch scale of the northern portion of Rajputana, between the meridian of 73° and 75° east longitude, the cantonment of Dagshai in 5 sheets, Jutogh in 1 sheet, Kasauli in 3 sheets, and Solon in 1 sheet.

* Major Badgley reports that all his Assistants worked well both in the field and in recess quarters.

58. The new surveys have also been incorporated in the sheets of the Simla and Kalka Road Survey.

59. This party, reduced by the transfer of three assistant surveyors and two Sub-Surveyors to other parties, will, during the current season, continue its work in Rajputana, extending the triangulation of the previous season northwards to the borders of Bahawalpur and the detail survey in degree sheet XX.*

IX.—THE MYSORE SURVEY (No. 8 TOPOGRAPHICAL PARTY).

60. The field operations of this party partly re-commenced on the 4th November 1880, but for the first two or three weeks of the season out-of-door work was rendered almost impossible by the continuous rain of the north-east monsoon which prevailed later than usual.

Personnel.

Major G. Strahan, R.E., Deputy Superintendent, 2nd grade, in charge.
Captain J. R. McCullagh, R.E., Assistant Superintendent.
Mr. R. Chew, Surveyor, 2nd grade.
„ A. J. James „ 4th „
„ F. Kitchen, Assistant Surveyor, 1st grade.
„ W. Stotsebury, „ „ 1st „
„ H. Todd, „ „ 1st „
„ G. Fleming, „ „ 3rd „
„ R. F. Warwick, „ „ 3rd „
„ J. Kennedy, „ „ 3rd „
and 10 Native Sub-Surveyors.

61. This survey is based on portions of the three principal series of triangles known as the "Great Arc Meridional," the "Mangalore Meridional," and the "Madras Longitudinal." It was commenced in 1875 for the Mysore Government, and at that time, in addition to the strictly topographical work on the scale of 1 inch equal to 1 mile, special surveys on a large scale of the various State forests within the province were contemplated; but after three of these forests, *viz.*, Bilikal, Nundydroog, and Dwarayadurga, had been completed, it was decided that no more were to be undertaken.

62. The districts in which the operations have been carried on during the year are "Shimoga," "Chitaldroog," "Kadur," and "Hassan." These operations may be conveniently divided into three classes, *viz.*, preliminary triangulation, topographical survey in detail by means of the plane-table and chain, and assistance rendered to the Boundary Commissioners in the determination of the Mysore-Kanara frontier.

63. The preliminary triangulation was extended over an area of about 820 square miles around the town of Shimoga in Sheets 23 and 24, in the southern part of which, in the Lakvalli Taluk, considerable difficulty was experienced owing to the rugged and jungly nature of the country. The detail survey was extended over an area of 3,438 square miles in Sheets 19, 20, 21, 25, 26, 27, 28, 29, and 49, the western portion of the work being carried on in exceedingly difficult ground, where the constant use of the chain, as an adjunct to the plane-table, was necessary in lieu of the more rapid means of working by intersections from known points. The eastern portion of the work was easier, and was allotted to the Native sub-surveyors. In accordance with instructions from the Surveyor-General, systematic attempts were made throughout the whole work to obtain a greater number of heights than had previously been customary, and these heights have been of great assistance to Major Strahan in the delineation of the fair maps. That officer who is an accomplished draftsman has produced some sheets, especially Nos. 27 and 29, in a style very superior to that shown in any of the previous work of this party.

64. The assistance rendered to the Boundary Commissioners consisted in supplying them with such maps as they required for the determination of the boundary, and in accompanying them when at work to introduce on the maps the positions of the various marks they caused to be erected; the nature of the country along the ghauts where the Mysore-Kanara frontier runs was such that the assistance of a professional Surveyor was imperative. This duty was undertaken by the Assistant Superintendent, Captain McCullagh, R.E., and carried out by him with much skill. This officer, after having served with the Mysore party, either in charge or as an assistant, for five years, has been transferred to the charge of a cadastral party working in Burma.

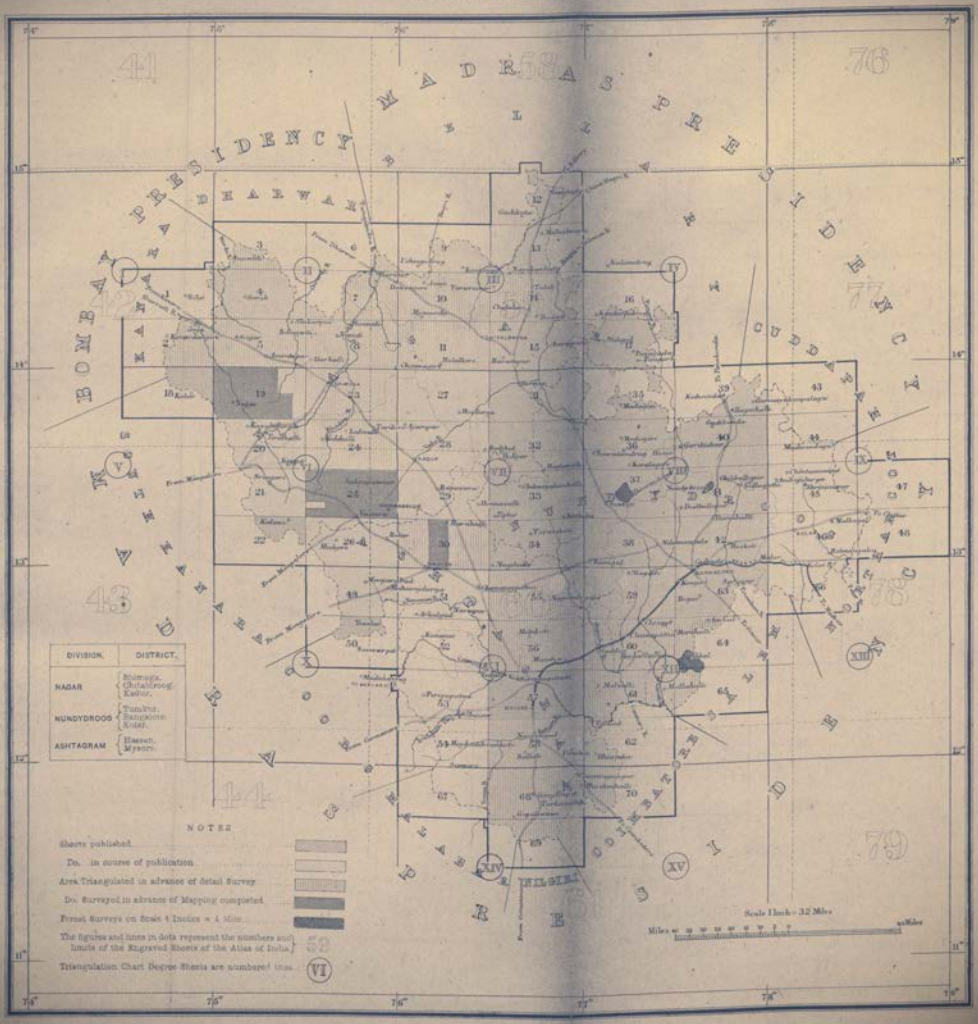
65. During the year under report much good work has been done, and sometimes under great difficulties, for all the Surveyors suffered more or less from fever. One of them, Mr. R. W. Chew, lost his life in the discharge of his

* Colonel DeFrée reports favourably of all the members of the party.

Nos. 8 & 9 PARTIES.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.



Published under the direction of Lieut. General J. T. Walker, C.B., R.E., F.R.S. Surveyor General of India.
at the Surveyor General's Office, Calcutta, October 1881.

duties, for he contracted a severe form of malarious fever in the Bhadra valley, which carried him off after his return to recess quarters in Bangalore. Having entered the Department in 1856, his services extended over a period of 25 years, during which his steady attention to his duties, and from an early date in his career his professional skill, have always been highly commended by the officers under whom he has served.

66. The present state of the work of this party is as follows :—

	Square miles.
Area surveyed up to the end of last field season	12,754
Area remaining for survey, about	17,800
Area triangulated in advance of detail survey	14,280

Major Strahan believes that the usually accepted area of 27,000 square miles in the province is considerably below the mark. He estimates the probable area to be about 30,500 square miles, and on this estimate the figures showing the area remaining for survey are based.

67. During the next season the detail survey on the scale of 1 inch equal to 1 mile will be carried in Sheets 2, 10, 11, 14, 15, 23, 24, 30, and 35, in the latter of which only a very small portion remains to be surveyed.*

X.—KOHAT DISTRICT SURVEY.

Personnel.

Major T. H. Holdich, R.E., Officiating Deputy Superintendent, 3rd grade.
Mr. T. E. M. Claudius, Surveyor, 4th grade.
„ W. W. McNair, Assistant Surveyor, 1st grade.
Sub-Surveyor, Imam Bux.
„ Hira Sing.
„ Atma Sing.

68. On the withdrawal of the British forces from Northern Afghanistan, it was arranged that some of the survey officers who had returned to India should be employed in making a standard topographical survey of the Kohat district, to supersede the preliminary reconnaissance survey which had been made in 1849-51—immediately after the annexation of the Punjab—and to complete the gaps remaining to be filled in on the frontier line up to the recent surveys in the Kurram Valley and other contiguous portions of Afghanistan. A full field season's work could not be expected, as all the officers were entitled to three months' special leave on return from Afghanistan, which fell in the field season, and thus practically reduced its length by one-half. Operations were, however, carried on by different persons in turns throughout the entire field season.

69. Mr. McNair was deputed early in the season to effect a more satisfactory junction between the triangulations in the Kurram Valley and the Kohat District than had been possible during the progress of the military operations. He was also directed to undertake the topography of the Meranzai Valley, through which the highway from Kohat to Kabul, *viâ* the Kurram, passes, and of which a good map had been urgently demanded by the local officials. The secondary triangulation executed in 1850-51 afforded material help in starting the new work, and providing a basis for the additional triangulation which is now required for a complete and accurate topographical delineation of the ground.

70. Major Holdich joined the party about the middle of February. Soon afterwards his services were needed with the force under Brigadier-General Gordon, C.B., which proceeded from Bannu to operate against the Mahsud Waziris. A separate report on the results obtained during this expedition is given under the heading "Geographical Surveys in Northern and Southern Afghanistan."

71. The total area covered by the triangulation in the Kohat District was 2,000 square miles. The area surveyed topographically on the 1-inch scale in the Meranzai Valley was 398 square miles, and 170 square miles of rough reconnaissance was obtained beyond the frontier in the Urakzai, Tirah, and Bam valleys. A native explorer completed a rough reconnaissance of the Zhob (Jobh) Valley, and afterwards rendered good service with the Waziri expedition.†

* Major Strahan commends very highly the services rendered by Captain McCullagh, Messrs. James Kitchen, and Stotesbury (special notice is made of Mr. Stotesbury's skill in drawing), and reports favourably on the work of Messrs. Todd, Fleming, and Warwick, and of Sub-Surveyors Janki Dass and Rajuvayengar.

† Major Holdich reports very favourably of the services rendered by Messrs. Claudius and McNair, and commends the work of the Native Surveyors.

XI.—THE GUZERAT TOPOGRAPHICAL SURVEY.

72. During the greater portion of the field season this party was under the charge of Colonel Haig, R.E., who made it over on the 12th April to Captain Hobday, temporarily, until the 26th April, when it devolved on Brevet-Lieutenant-Colonel Leach, V.C., R.E. The latter officer retained charge until Colonel Haig rejoined on the 27th October, on his return from Venice, after the conclusion of his duties as one of the delegates on the part of the Indian Government to the Venice Exhibition.

Personnel.

Colonel C. T. Haig, R.E., Officiating Deputy Superintendent, 1st grade, to 12th April 1881.
Brevet-Lieutenant-Colonel E. P. Leach, V.C., R.E., Officiating Assistant Superintendent, 1st grade, from 26th April 1881.
Captain J. Hobday, S.C., Officiating Assistant Superintendent, 2nd grade, from 12th April 1881.
Mr. T. A. LeMesurier, Assistant Superintendent, Revenue Survey.
„ A. D'Souza, Surveyor, 1st grade.
„ A. D. L. Christie, Surveyor, 4th grade.
„ C. H. McAFee, „ 4th „
„ C. Tapsell, Assistant Surveyor, 1st grade.
„ G. D. Cusson, „ „ 1st „
„ S. F. Norman, „ „ 4th „
„ C. A. Norman, „ „ 4th „
„ A. George, „ „ 4th „
Sub-Surveyor Lakshman Ghorpade.
„ Gopal Vishnu.
„ Bhan Govind.
„ Govind Gopal.
„ Ballwant Govind.
and 24 others, including apprentices.

73. During the year under review three descriptions of work have been carried on, as previously,—

1*st*, the ordinary topographical survey executed on the 2-inch scale for publication on the 1-inch scale.

2*nd*, the preparation of a series of maps of British territory from the ordinary survey, with the addition of much detail derived from the Cadastral Surveys of the Bombay Revenue and Settlement Department for publication on the 2-inch scale.

3*rd*, the survey of the Dang Forests on the 4-inch scale.

74. The area surveyed on the 2-inch scale amounts to 1,585 square miles, territorially divided as follows:—

		Square miles.
British	Surat Collectorate	466
	Ahmedabad Collectorate	1
	Khandesh, bordering the Dangs	47
Foreign	Baroda	1,012
	Mahi Kanta	28
	Rewa Kanta	28
	Radhanpore	3

It falls within the limits of Sheets Nos. 17, 33, 34, 35, 49, and 77, and exceeds by 527 square miles the area surveyed on the same scale during the previous year.

75. On the 4-inch scale an area of 76 square miles was completed in the Dangs, in continuation of previous work in the same forest tract; this falls short of the area accomplished last year by 35 square miles.

76. The several operations complete the area topographically surveyed in Guzerat up to about 14,300 square miles, leaving an area of some 16,700 square miles for future survey.

77. The season's triangulation covers an area of 1,543 square miles, fixing the positions of 829 stations and other points, of 296 of which the heights also were determined. The aggregate length of the lines traversed was 795 miles. Several bench marks of the Irrigation Department, which had been connected with Captain Baird's lines of levels, were fixed in the course of the plane-tabling, and their positions and heights will be shown on the maps. The total area now triangulated in advance of the topography is 3,559 square miles, over 859 of which traverses have been carried for the incorporation of details from the cadastral and settlement survey operations in British territories.

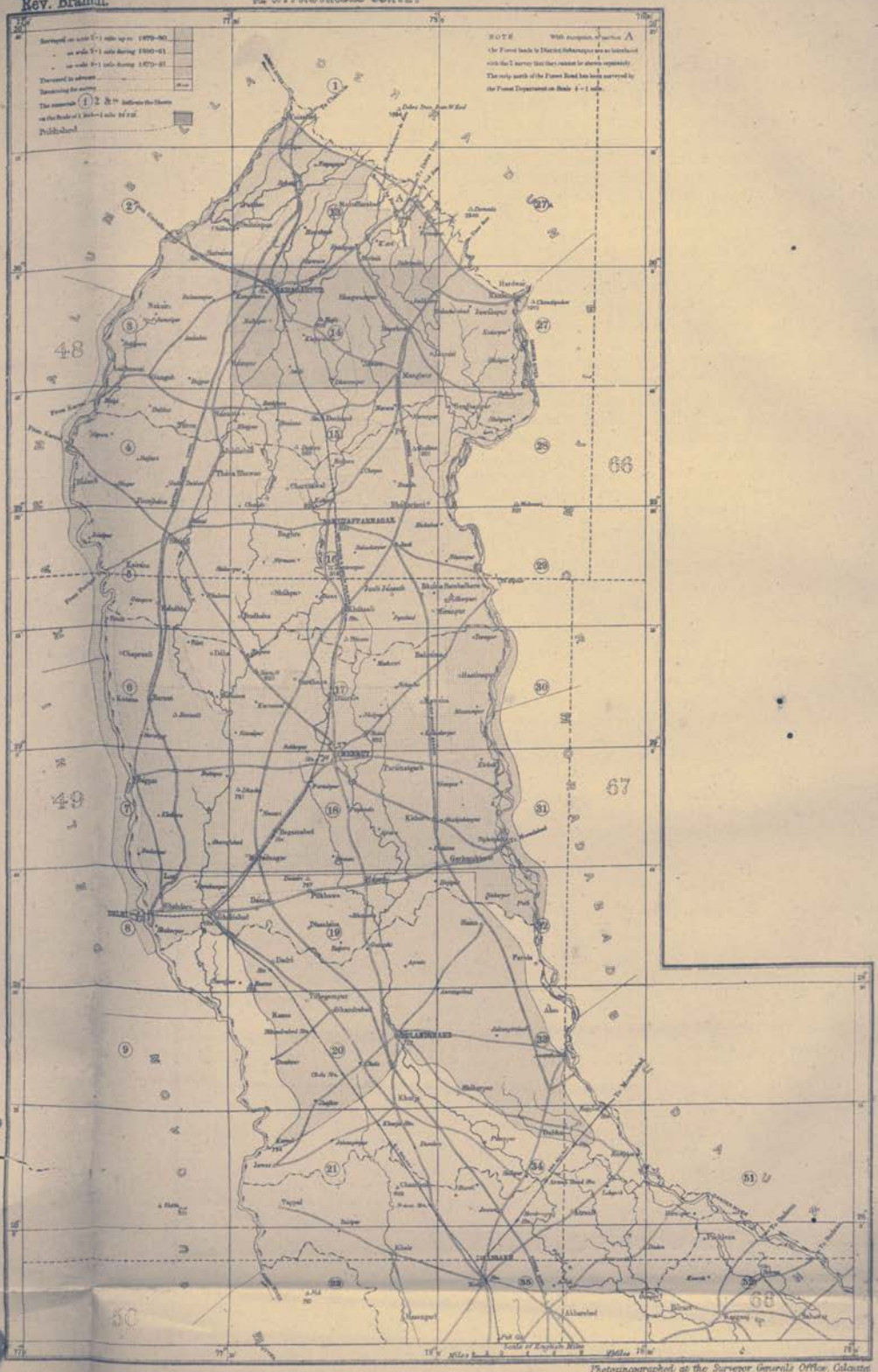
78. Much misadventure befell the operations in the Dang Forests. This tract of country has always caused much anxiety owing to its malarious nature; but the portions which had been surveyed in former years were believed to be the most malarious, as they were certainly the most intricate and difficult. What remained for survey had been found, in the course of the triangulation of the previous year, to be more open, and it was well-studded with villages connected by cart roads, thus forming a marked contrast with the western portions already surveyed. Consequently Colonel Haig had anticipated that the operations might be commenced with impunity at the beginning

SURVEY OF INDIA.

INDEX CHART of the GUZERAT SURVEY.

No. 3 PARTY,
Rev. Branch.

INDEX TO THE
N. W. PROVINCES SURVEY


Surveyed on scale 8 = 1 mile up to 1879-80
on scale 4 = 1 mile during 1880-81
on scale 8 = 1 mile during 1879-81
Traversed in advance
Remaining for survey
The numerals 1 2 & 3 indicate the Sheets on the Scale of 1 Inch = 1 mile 30 x 22
Published
NOTE With exception of portion A the Forest lands in District Saharanpur are so interlaced with the Ryotwar lands that they cannot be shown separately. The only march of the Forest Road has been surveyed by the Forest Department on Scale 4 = 1 mile.
SAHARANPUR
MUZAFFARNAGAR
MEERUT
BULANDSHAHR
ALIGARH
48
49
50
66
67
68
Scale of English Miles

Photozincographed at the Surveyor Generals Office, Calcutta

Published under the direction of Lieut-General J.T.Walker, C.B-R.E.-F.R.S., Surveyor General of India.

Surveyor Generals Office, Calcutta, December
1881

of the field season, and be carried on by a few surveyors working continuously until the end of the season; whereas formerly it had been postponed until the month of March, when several surveyors were transferred from distant points of the general survey for employment in the Dangs, thus causing much loss of time during the season when field work is alone possible, and when it is of importance that all hands should be at full work in the field. Unfortunately the experiment failed. Early in the season the ground is covered with a dense growth of high grass, and this was found to impede the operations greatly; moreover all the surveyors, both European and Native, with a single exception, fell ill and had to be removed; thus the out-turn of work fell much below what had been expected. It will be necessary in future to revert to the previous system of postponing the commencement of operations in this region until the month of March, when the country is not only free from malaria and quite healthy, but is more open and easily surveyed, as the long grass has by that time been cut down and removed.

79. During the year ten sections of the maps on the 2-inch scale—six for reduction to half scale and four for reproduction to full scale—and three sections of the 4-inch maps, were completed and sent in to head-quarters for publication; and reductions of Sheets 14 and 27 were prepared for incorporation into the Indian Atlas. Nineteen other sections were nearly completed, and will soon be available for publication. The ordinary mapping was unavoidably retarded to some extent, as the services of some of the draftsmen were required for the maps of Kandahar and the surrounding country, which were necessarily drawn in this Office under the superintendence of Lieutenant-Colonel Leach, on the withdrawal of the British army from Southern Afghanistan. These maps will be noticed in the geographical section of this report.

80. Several of the maps of this survey were sent for exhibition to the Geographical Congress at Venice, where they attracted much notice, the more so that Colonel Haig was on the spot and was able to give full information regarding the method which he had adopted for utilizing the chief topographical results of the cadastral surveys previously made by the Settlement Department, and combining them with the operations of this survey. His work was much appreciated, and one of the few gold medals presented by the Congress to exhibitors was awarded to him.

81. The special operations for which the services of Mr. LeMesurier and a small Native establishment of the Bombay Revenue and Settlement Department have for some years been accorded to this survey, were completed during the present year, when Mr. LeMesurier was re-transferred to his own department. He has been attached to the Guzerat Survey for eight years, during which he has rendered much valuable service in map-drawing and other particulars, as well as in conducting the operations necessary for the incorporation of the survey work of the Settlement Department.*

XII.—THE SURVEY OF DISTRICTS MEERUT AND BULANDSHAHR, NORTH-WEST PROVINCES. (No. 3 PARTY, REVENUE BRANCH.)

82. Field operations were resumed under the charge of Major W. H. Wilkins on the 16th October 1880, and were continued up to the 15th April 1881.

Personnel.

Major W. H. Wilkins, Deputy Superintendent, 3rd grade, in charge (on duty in the Deputy Surveyor General's Office from 6th to 27th September 1881).
Mr. E. C. Ryall, Officiating Assistant Superintendent, 2nd grade (in charge from 18th to 31st August 1881), transferred to Darjeeling Survey from 1st September 1881.
Mr. James Todd, Surveyor, 3rd grade, was in charge from 1st to 30th September 1881.
Mr. R. C. D. Ewing, Assistant Surveyor, 1st grade.
„ C. W. Wilson, „ 1st „
„ C. W. F. Seyers „ 1st „
31 Sub-Surveyors, &c.

The party has chiefly been employed on a topographical survey on the 2-inch scale in the Meerut District, but has also carried on a 4-inch survey of a line of villages on both banks of the Jumna River. On the 2-inch scale, 1,539 square miles have been surveyed, which include 31 square miles surveyed on the left bank of the Ganges, on account of changes in the river since the time of the last survey;

* The European surveyors attached to this party have all worked well. Colonel Haig commends the Native sub-surveyors whose names are mentioned above; but the sub-surveyors of this party, mostly men trained in the Government schools and the College at Poona, appear, as a rule, to be deficient in physique, and better suited for Office work than for field work; there was much real sickness among them, but some malingering also; thus the introduction of new men of a better stamp appears to be very desirable.

and on the 4-inch scale, 150 square miles have been surveyed on both sides of the Jumna. In addition to the completed area, preliminary traversing has been executed over 973 square miles in District Bulandshahr.

83. The survey on both scales has been as minute as the scale admitted, special attention having been given to all lines of drainage. Many bench marks had previously been fixed in the Meerut District during leveling operations carried out by the Trigonometrical Branch and by the Canal Department; these have all been identified and are shown on the maps. The village boundaries have been inserted on the topographical survey maps, as during previous seasons, by transfer from the settlement maps, except in the low-lying lands of the Ganges River, where the boundaries have been obtained by actual survey.

84. In the village survey on the Jumna River, the boundaries of one line of villages on the Meerut side have been fully surveyed. But on the Delhi side, the boundaries have only been surveyed as far as the land was subject to be covered by the river; and on the uplands, the boundaries have been taken by transfer from the survey maps of the Delhi District.

85. The topographical survey has now been completed down to latitude 28° 45′; and as the maps, both for reproduction on the 2-inch scale and for reduction to the 1-inch scale, have all been drawn, it is hoped that they will soon be published. The maps, however, on which the boundary of the Saharanpur District common with Ambala appears, cannot yet be published, as that boundary is still undecided.

86. In the Meerut District, there now remain for survey 329 square miles which will be completed during the coming season, and the topographical survey of the Bulandshahr District will be commenced. The Aligarh District is the next in order for topographical survey, and some preliminary traversing will be done there. The village survey on the Jumna will be carried on up to the point where the river, ceasing to form the boundary between the North-Western Provinces and Punjab, turns into the Muttra District. On the Ganges River, a village survey will be commenced, under recent orders of Government, similar to that which has been carried out on the Jumna.

87. The office of the party was inspected by the Deputy Surveyor-General at Mussooree during October. The field plans exhibited great care in the execution of the survey, and the fair maps were being drawn in excellent taste.*

XIII.—THE SURVEY OF CUTCH.

88. The operations in Cutch were commenced last year on the completion and in continuation of those in the adjoining Province of Kattywar (Kathiawar). In its topographical aspects, the region to be surveyed is very variable, presenting masses of hilly ground with concomitant valleys and deep watercourses, alluvial plains which are cultivated and dotted about with towns and villages, and an extensive featureless sandy waste which is well known as the Rann of Cutch. The two former are being surveyed on the scale of 2 inches to the mile for reduction to the 1-inch scale, as in the Kattywar survey. But for the Rann the $\frac{1}{2}$-inch scale has been adopted, which is amply sufficient for its requirements. The topography is generally based on triangulation, but in the Rann, traversing is employed, being best suited for the nature of the country.

Personnel.

Major A. Pullan, S.C., Deputy Superintendent, 3rd grade.
Mr. N. C. Gwynne, Surveyor, 4th grade.
„ W. A. Fielding, Assistant Surveyor, 1st grade.
„ G. T. Hall, „ 2nd „
„ P. F. Prunty, „ 3rd „
Sub-Surveyors, V. R. Godboli.
„ N. D. Patwardhan.
„ G. R. Bhopatkar.
„ R. V. Kolarkar.
and 7 others.

89. During the present year an area of 1,658 square miles was surveyed on the 2-inch scale: it lies generally to the west of Bhuj, the capital of the prov-

* Major Wilkins reports of his Assistants in the following terms:—

"Mr. Ryall, Assistant Superintendent, gave great satisfaction in the discharge of his field duties." Messrs. Todd and Ewing have rendered "valuable assistance both in the field and recess." Messrs. Wilson and Seyers have given "great satisfaction." The following named Sub-Surveyors and others have given the "best satisfaction," *viz.*, Kedar Nath, Bhugobutty Chackerbutty, Sarfraz Khan, Mahomed Zakaria, Irfan Ali, Nejabut Hoosain, Alladad Khan, Bashirudin, Sharafudin, Boithram, Hira Singh, Abdool Karim.

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.

GWALIOR &
CENTRAL INDIA
SURVEY
GUJERAT
SURVEY
RAJPUTANA
SURVEY
INDUS RIVER SURVEY
EASTERN NARA SURVEY
CUTCH
KHARIA
LITTLE RANN
GULF OF CUTCH
KATHIAWAR
PORBUNDAR
JAMNAGAR
MORVI
WANKANER
DHRANGADRA
HALWAD
JODIA
KALYANPUR
DWARKA
OKHAMANDAL
MANDVI
MUNDRA
ANJAR
BHUJ
LAKHPAT
NARA
PACHBHADRA
RADHANPUR
DEESA
PALANPUR
DHANERA
VAV
THARAD
KANKREJ
SANTALPUR
SIDHPUR
PATAN
KHERALU
KADI
KALOL
MEHSANA
VIJAPUR
HIMATNAGAR
IDAR
KHERWARA
ABU
SIROHI
PALANPUR
DEESA
RADHANPUR
SANTALPUR
PATAN
MEHSANA
KALOL
KADI

ince, and between the decaying town of Lakpat and the thriving port of Mandvi. A further area of 813 square miles was surveyed in the Rann on the ½-inch scale. An area of 1,360 square miles was triangulated, fixing the positions of 468 new stations and points, of 238 of which the heights also were determined. Check traverses, aggregating 425 miles in length, were carried over the topography.

90. A sub-surveyor was sent to Kattywar to survey certain boundary lines between the Native States which had only recently been demarcated, not having been settled at the time of the survey of the province, and which have therefore been hitherto shown on the maps as only 'approximate.' These lines were scattered apart at wide intervals, and thus took some time to complete, though the aggregate length amounted to only 74 miles. Major Pullan reports that the Political Agent in Kattywar considers that further boundary surveys in that province are unnecessary on the part of this Department, "as "the few disputed boundaries which now exist are inconsiderable, and can be "from time to time communicated to the Survey Department at such time as "they may be finally demarcated."

91. During the recess season, fair maps of four Sheets—5, 13, 14, and 16—on the 2-inch scale, and four Sheets—3, 4, 10, and 11—on the ½-inch scale, have been prepared for publication. The whole of the computations have been brought up to date. The general reports on Degree Sheets IX and X of Kattywar have been completed for transmission to head-quarters *

XIV.—THE SURVEY OF THANA AND COLABA COLLECTORATES, KONKAN, BOMBAY PRESIDENCY (No. 10 PARTY, REVENUE BRANCH).

92. Colonel J. Macdonald, who held charge of this party during the previous year, having retired from the service, was relieved on the 13th November 1880 by Major H. L. Smith, who has since that date been in executive charge of the party.

Personnel.

Colonel J. Macdonald, Deputy Superintendent, 2nd grade, in charge up to 12th November 1880.
Major H. Lees Smith, Officiating Deputy Superintendent, 3rd grade, transferred from No. 1 Party from 1st October 1880, in charge from 13th November 1880.
Mr. A. M. Lawson, Surveyor, 3rd grade.
" J. Newland, Assistant Surveyor, 1st grade.
" W. M. Kelly, " 2nd "
" K. R. Dickinson, " 2nd "
19 Sub-Surveyors, &c.

93. The area topographically surveyed is 1,610 square miles, included in Talukas Alibag and Pen of the Colaba Collectorate; and in Talukas Panvel, Karjat, Kalyan, Salsette, and Murbad of the Thana Collectorate, a further area of 700 square miles has been triangulated and traversed in advance. Field operations were commenced on the 24th November and closed on the 25th May. The scale and nature of survey have been the same as those of previous years, the scale being 2 inches to a mile, and the mapping being rendered on the scale of survey, but drawn for reduction to the 1-inch scale.

94. The following extracts from Major Lees Smith's report describe the general character of the country, and treat of other matters connected with the survey:—

"The country under survey consisted of either high and difficult hills covered with forests, or of a marshy flat country along the sea cut up in every direction by tidal creeks, which constantly prevented the Surveyors going straight from one point to another, or of sending out flags to aid them in the topography. The result was that men who could easily get over 40 square miles a month in the Deccan, have not been able to do 25 square miles in the country we were in this season."

* * * * * * * *

"The survey of the suburbs of Bombay, including Salsette, Thana, Kalyan, &c., was very intricate. The hill sanitarium of Matheran and Bombay Harbour came into the work and were difficult to survey."

* * * * * * * *

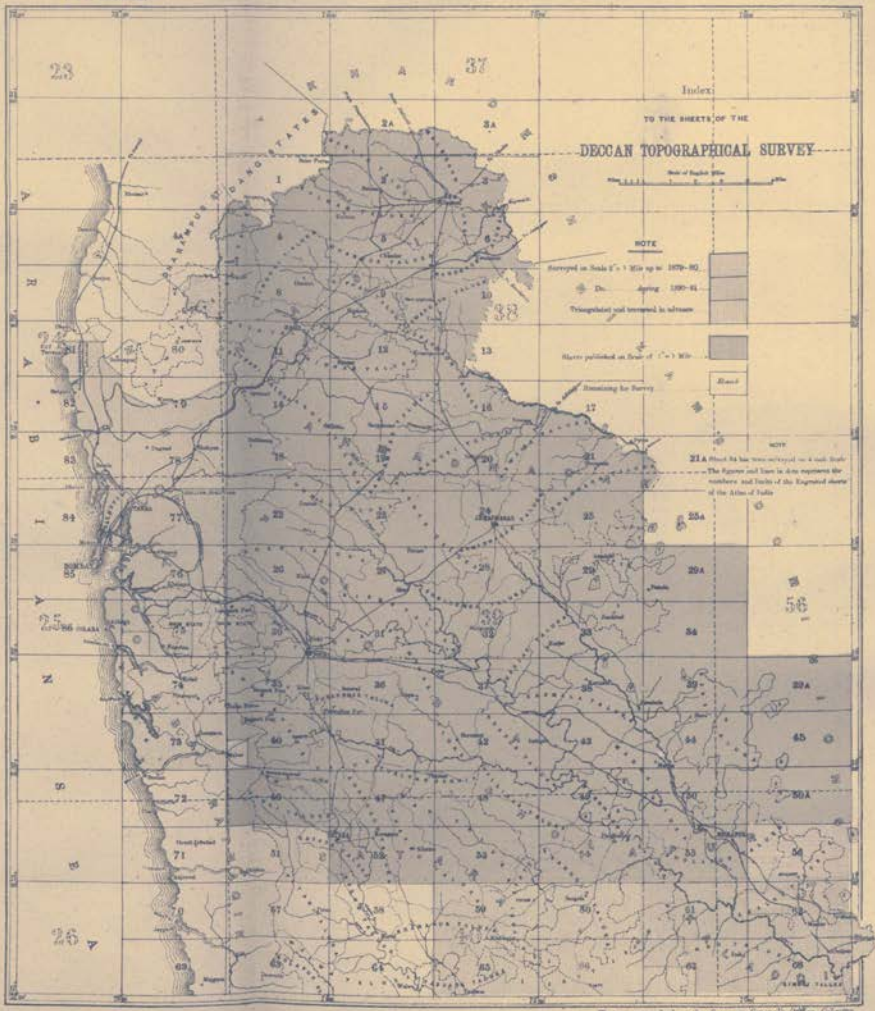
"The health of the Establishment throughout the field season was not satisfactory. Fever at the commencement, and guinea-worm all through caused a great diminution of working power."

* * * * * * * *

* Major Pullan reports very favourably on the work of all his European Assistants, and commends Sub-Surveyors Kolarkar, Bhoputkar, Patwardhan, and Joshi for very creditable out-turns of work; the two last in the Rann, where they were "often hard put to it for food, fuel, and water."

Nos. 10 & 11 PARTIES.
Rev. Branch.

DECCAN TOPOGRAPHICAL SURVEY



Photozincographed at the Surveyor Generals Office, Calcutta.

Published under the direction of Lieut-General J.T.Walker, C.B.-R.E.-F.R.S., Surveyor General of India.

Surveyor Generals Office, Calcutta. December

1881

ince, and between the decaying town of Lakpat and the thriving port of Mandvi. A further area of 813 square miles was surveyed in the Rann on the $\frac{1}{2}$-inch scale. An area of 1,360 square miles was triangulated, fixing the positions of 468 new stations and points, of 238 of which the heights also were determined. Check traverses, aggregating 425 miles in length, were carried over the topography.

90. A sub-surveyor was sent to Kattywar to survey certain boundary lines between the Native States which had only recently been demarcated, not having been settled at the time of the survey of the province, and which have therefore been hitherto shown on the maps as only 'approximate.' These lines were scattered apart at wide intervals, and thus took some time to complete, though the aggregate length amounted to only 74 miles. Major Pullan reports that the Political Agent in Kattywar considers that further boundary surveys in that province are unnecessary on the part of this Department, "as "the few disputed boundaries which now exist are inconsiderable, and can be "from time to time communicated to the Survey Department at such time as "they may be finally demarcated."

91. During the recess season, fair maps of four Sheets—5, 13, 14, and 16—on the 2-inch scale, and four Sheets—3, 4, 10, and 11—on the $\frac{1}{2}$-inch scale, have been prepared for publication. The whole of the computations have been brought up to date. The general reports on Degree Sheets IX and X of Kattywar have been completed for transmission to head-quarters *

XIV.—THE SURVEY OF THANA AND COLABA COLLECTORATES, KONKAN, BOMBAY PRESIDENCY (No. 10 PARTY, REVENUE BRANCH).

92. Colonel J. Macdonald, who held charge of this party during the previous year, having retired from the service, was relieved on the 13th November 1880 by Major H. L. Smith, who has since that date been in executive charge of the party.

Personnel.

Colonel J. Macdonald, Deputy Superintendent, 2nd grade, in charge up to 12th November 1880.
Major H. Lees Smith, Officiating Deputy Superintendent, 3rd grade, transferred from No. 1 Party from 1st October 1880, in charge from 13th November 1880.
Mr. A. M. Lawson, Surveyor, 3rd grade.
" J. Newland, Assistant Surveyor, 1st grade.
" W. M. Kelly, " 2nd "
" R. R. Dickinson, " 2nd "
19 Sub-Surveyors, &c.

93. The area topographically surveyed is 1,610 square miles, included in Talukas Alibag and Pen of the Colaba Collectorate; and in Talukas Panvel, Karjat, Kalyan, Salsette, and Murbad of the Thana Collectorate, a further area of 700 square miles has been triangulated and traversed in advance. Field operations were commenced on the 24th November and closed on the 25th May. The scale and nature of survey have been the same as those of previous years, the scale being 2 inches to a mile, and the mapping being rendered on the scale of survey, but drawn for reduction to the 1-inch scale.

94. The following extracts from Major Lees Smith's report describe the general character of the country, and treat of other matters connected with the survey:—

"The country under survey consisted of either high and difficult hills covered with forests, or of a marshy flat country along the sea cut up in every direction by tidal creeks, which constantly prevented the Surveyors going straight from one point to another, or of sending out flags to aid them in the topography. The result was that men who could easily get over 40 square miles a month in the Deccan, have not been able to do 25 square miles in the country we were in this season."

* * * * * * * *

"The survey of the suburbs of Bombay, including Salsette, Thana, Kalyan, &c., was very intricate. The hill sanitarium of Matheran and Bombay Harbour came into the work and were difficult to survey."

* * * * * * * *

"The health of the Establishment throughout the field season was not satisfactory. Fever at the commencement, and guinea-worm all through caused a great diminution of working power."

* * * * * * * *

* Major Pullan reports very favourably on the work of all his European Assistants, and commends Sub-Surveyors Kolarkar, Bhoputkar, Patwardhan, and Joshi for very creditable out-turns of work; the two last in the Rann, where they were "often hard put to it for food, fuel, and water."

"The survey of the salt marshes necessitated the men spending hours up to their waists in mud."

A few notes by Major Lees Smith descriptive of the country are printed with the appendices.

95. All the features of the country, as far as the scale admitted, were fully surveyed; the village boundaries were also surveyed and were afterwards compared with the Provincial survey maps. Except in hilly country, the agreement between the two surveys of the boundaries was satisfactory. Additional traversing with theodolite observations, beyond what would be required for a purely topographical survey, was carried out for the purpose of furnishing the Provincial revenue survey with the co-ordinates of all village trijunctions. In all, 3,246 permanently marked stations on village boundaries have been fixed by these traverses.

Besides the usual heights of trigonometrical stations on hills, the heights of many selected points on hill passes, embankments, parapets of wells, cross roads, junctions of streams, and milestones have been determined. The accuracy of the topography was tested by check surveys aggregating 94 miles carried over the open and level parts of the country. In the hilly country there was an examination of the plans, *in situ*, by the executive officer and his senior assistant.

96. The fort and city of Bombay have not been surveyed, but have been mapped from a photographic reduction of the survey executed by Colonel Laughton in 1874. This reduction has been incorporated with the topographical survey so as to complete Sheets Nos. 84 and 85; and, as far as possible, any important buildings which have been constructed since the survey have been added. The mapping of Sheets Nos. 75, 76, 77, 84, 85, and 86 has been completed on the 2-inch scale. The reduction for the Atlas of India of 10 Sheets, area 4,800 square miles, has been proceeded with.

97. The operations of the party for next field season will be conducted on the increased scale of 4-inches to a mile, and will include, besides the details usually shown on this scale, a certain amount of special information for the Forest Department, as well as the boundaries of the villages and of the forest reserves.*

XV.—THE SURVEY OF SHOLAPUR, KALADGI, AND SATARA COLLECTORATES, BOMBAY PRESIDENCY (No. XI PARTY, REVENUE BRANCH).

98. Major H. S. Hutchinson, who conducted this party from the recess station into the field, was relieved of the executive charge by Major D. C. Andrew on the 25th December 1880. Field operations were commenced on the 11th November 1880, and continued up to 15th May 1881.

Personnel.

Major D. C. Andrew, Deputy Superintendent, 3rd grade, transferred from No. 8 party, and in charge from 25th December 1880.
Major H. S. Hutchinson, Officiating Assistant Superintendent, 1st grade, in charge up to 24th December 1880, and transferred to No. 4 party from 1st January 1881.
Mr. S. M. Smylie, Surveyor, 3rd grade.
" J. Hickie, Assistant Surveyor, 1st grade.
" G. C. Swiney, " 1st "
" W. H. Penrose, " 2nd "
" G. A. Knight, " 3rd "
22 Sub-Surveyors, &c.

99. The area surveyed topographically, which falls in Sheets 61, 62, 67, 68, the scale of survey being that of 2 inches to a mile, is distributed as follows:—

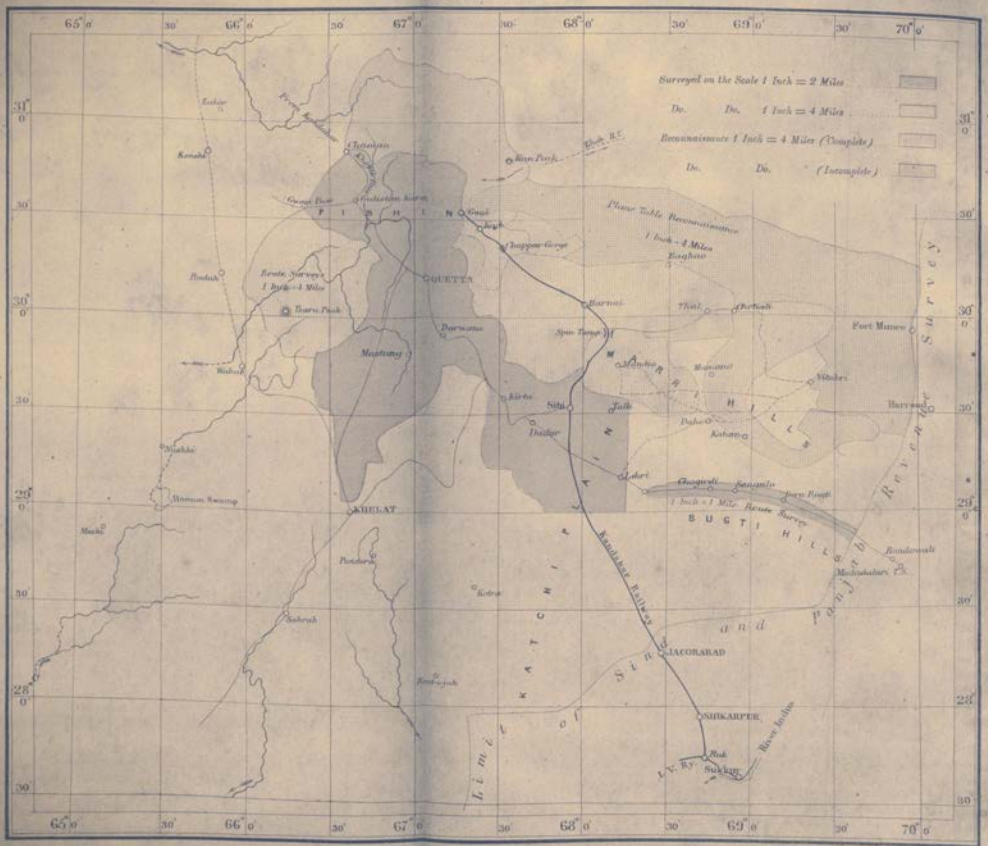
	Square miles.
Sholapur Collectorate and one dependent state . . .	256·78
Kaladgi ditto	1008·16
States dependent on Satara Collectorate	392·14
Nizam's Dominions	379·12
Total .	2036·20

The portion of the Nizam's Dominions has been surveyed, as there are no maps of this tract forthcoming with the records of the Hyderabad survey. Besides the area of topographical survey, preliminary triangulation and traversing have been carried out over an area of 820 square miles.

* Major Lees Smith reports in most favourable terms on the good services of Messrs. Lawson and Newland, his senior Assistants, and the juniors, Messrs. Kelly and Dickinson, are said to have worked to his entire satisfaction. From among the Native establishment, Major Lees Smith brings specially to notice the names of Lingoji Potana, Fyzulla Khan, Damodar Gopal, and Inayatulla Khan.

INDEX to the SHEETS of the BALUCHISTAN SURVEY.

Scale 1 Inch = 2 Miles.



Published under the direction of Lieut. General J. T. Walker, C.B., R.E. F.R.S., Surveyor General of India
at the Surveyor General's Office, Calcutta. February 1861.

100. The country is described by the executive officer as consisting of low, undulating hills, the summits being generally level. There is almost an entire absence of trees, and the want of shade during the last months of the field season was severely felt. The villages are small and far apart, and there is a scarcity of good drinking water.

101. The survey of the city of Sholapur, on the 80-inch scale, at the expense of the Municipality, has been continued, and owing to the large scale adopted, has proved a very laborious undertaking.

102. Sheets Nos. 61, 62 and 68 have each been drawn in 4 sections on the 2-inch scale, and will shortly be published each in one map on the 1-inch scale. The preparation of a reduced map, to the scale of the Atlas of India, of the work of previous seasons has been undertaken, and has entailed the reduction by pentagraph of 28 sheets of the 1-inch series.*

XVI.—THE OPERATIONS IN BELUCHISTAN.

103. The survey beyond the Sind frontier, in Beluchistan and in Sewestan and the Marri Hills, was continued during the season wherever practicable. The climate of the country is peculiar and renders it difficult to arrange satisfactorily for the division of field and recess duties as in India. From March to November the low country is intensely hot, and from November to March the highlands between Quetta and Khelat are intensely cold. During the months of June, July, and August thick haze prevails. The months of April, May, September, and October are said to be most favourable for survey work in the more elevated regions, and November, December, January, and February for work in the low grounds, and if advantage be fully taken of these months to push on with field duties, a very short recess season follows. Major Beavan reports that the field season under review lasted ten months.

Personnel.

Major R. Beavan, S. C., Assistant Superintendent.
Mr. J. T. U. Coxen, Assistant Surveyor, 1st grade.
„ H. Corkery „ 2nd „
and 3 Native Surveyors.

104. The triangulation was advanced in continuation of the work of the previous season, but it is not possible at present to define the area completed as many of the angles are still unmeasured.

105. Operations cannot be carried on in regular continuity, as in the regular surveys, but have to be taken up wherever and whenever favourable opportunities occur. The triangulation was extended and observations were taken at 8 hill stations from which a number of points were fixed for future requirements. An area of 3,500 square miles was surveyed in more or less detail on the $\frac{1}{2}$-inch scale between Quetta and Khelat. In the hills north-east of Quetta, inhabited by the Dumar Pathans, which Major Beavan visited under the protection of the chief of the tribe, and in Sewestan, a further area of 2,800 square miles was reconnoitred and mapped on the $\frac{1}{4}$-inch scale.

106. Major Beavan accompanied the expedition under Brigadier-General MacGregor into the Marri country during October, November, and December 1880, but unfortunately was not able to obtain much new geographical information, as he had no basis of fixed points for plane-tabling, and the unsettled state of the country rendered it impossible for him to leave the line of march in order to ascend any commanding points from which a good view of the country could be obtained. A survey of the actual line of route taken by the troops was made by continuant bearings and pacings by Captain Gill, R.E., who accompanied the expedition as a volunteer; this survey formed the basis of the map which was subsequently published to illustrate the movements of the troops.

107. Major Beavan gives an interesting description of all the country visited by him during the season's operations, which will be found in the appendix. During the next season the topography on the $\frac{1}{2}$-inch scale of the hilly ground east and west of the Rodhar road and pass from latitude 29° 45′ to 29° 15′ will be taken up, so as to fill the blank between the survey completed in 1879 and that done during the season under review, and if possible the hills to the west and south of Harnai below the line of railway will be reconnoitred.†

* All the Assistants of the party are reported by Major Andrew to have given the utmost satisfaction both in the field and during the recess, with the exception of Mr. Penrose.

† Major Beavan reports favourably of Messrs. Coxen and Corkery.

MAUZAWAR OR VILLAGE SURVEY.

XVII.—DERA ISMAIL KHAN AND RAWALPINDI DISTRICTS (No. 1 PARTY, REVENUE BRANCH).

108. This party proceeded from recess quarters at Murree to the field in two sections. The first section commenced work in the Kala Chitta Range of hills in the Rawalpindi District on 15th October, and the second section in Parganas Bhakkar and Leia of the Dera Ismail Khan District on 1st November. Field work was closed on the 15th April and 1st April by the two sections respectively, and the recess office was re-opened at Murree on 1st May. For one Surveyor of the party, the field season, however, did not then terminate. An urgent call had been received from the Military Department for surveys of the Hutted Camps in the Rawalpindi and Hazara Districts in the neighbourhood of Murree, and the maps were required at an early date. This work was assigned to Mr. G. B. Scott, who continued at work during the dry months of May and June, working also, as opportunity offered, during the subsequent rainy months; and by the middle of September Mr. Scott had completed the surveys of all the Camps, seven in number.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent, 2nd grade, in charge.
Mr. G. B. Scott, Surveyor, 3rd grade.
„ W. S. Buttress, Surveyor, 3rd grade.
„ A. J. Gibson, „ 4th „
„ R. Todd, Assistant Surveyor, 1st grade.
„ P. A. Peters, Assistant Surveyor, 3rd grade, transferred to Cachar Settlement Survey from 1st December 1880.
„ J. C. Kelly, Assistant Surveyor, 3rd grade.
24 Sub-Surveyors, &c.

109. The following statement shows the separate areas of the different operations on which the party has been engaged:—

District.	Parganas and other names.	Scale 4 inches to a mile.	Scale 12 inches to a mile.
		Square miles	Square miles
Dera Ismail Khan	Pargana Bhakkar	893·4	...
	„ Leia	1049·1	...
Rawalpindi	Kala Chitta Range	371·4	...
	Thobba Camp	...	
Hazara	Khyra Gali	...	3·7
	Changla Gali	...	
	Kalabagh and Bara Gali	...	
	Ghora Dhaka and Koonja Gali	...	
	TOTAL	2313·9	3·7

110. The Kala Chitta Range is being surveyed for the Forest Department. The forest reserve is said to include nearly the whole of the Range, but the survey has not been confined to the reserve alone, as the entire areas of all villages, portions of which had been taken into the reserve, were required to be surveyed. The forest boundary was found to be prominently demarcated and the pillars are shown on the maps. Colonel Macdonald gives the following description of the Range:—

"The whole tract is very broken and rugged. The hills are covered with bush and low tree jungle, principally the wild olive. There is great scarcity of water, which had to be carried for the survey parties sometimes for long distances."

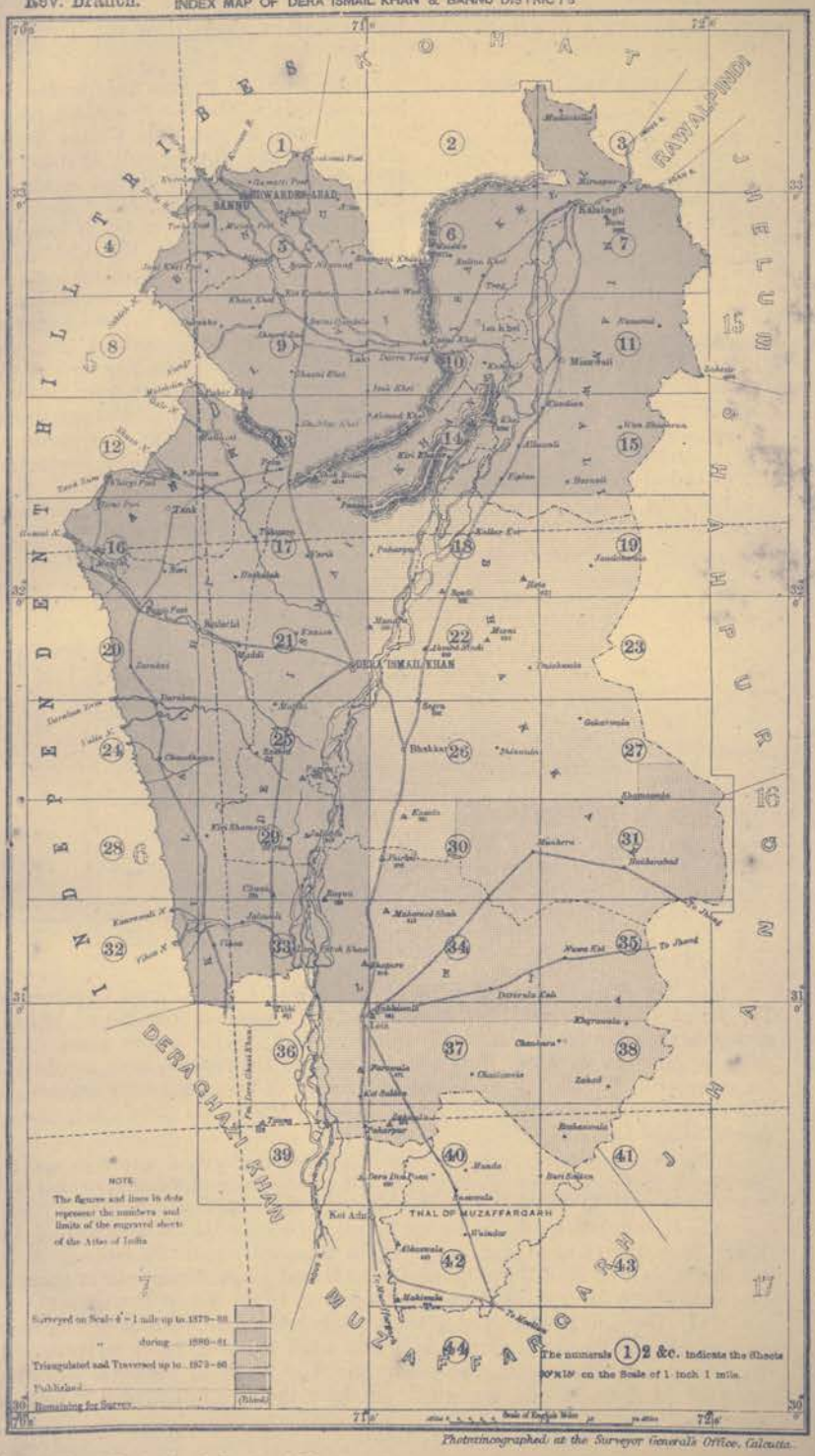
The triangulation of the Range has been completed. The maps of the Kala Chitta Range have been drawn to the standard size of $3\frac{3}{4}'$ latitude $\times$ $7\frac{1}{2}'$ longitude. Of these, 13 have been completed, and photozincographs of them on the scale of the survey will shortly be made over to the Forest Department.

111. The country surveyed in the Dera Ismail Khan District is described as "open, slightly undulating, sandy, with a few scattered hamlets, sparse cultivation, and generally very easy to survey. The principal obstacles were the want of good water and the great distances the men had to send to procure supplies."

No. 1 PARTY,
Rev. Branch.

PUNJAB SURVEY

INDEX MAP OF DERA ISMAIL KHAN & BANNU DISTRICTS


BANNU
EDWARDESABAD
DERA ISMAIL KHAN
THAL OF MUZAFFARGARH
RAWALPINDI
JHELUM
SHAHPUR
GOGHAIRA
MUZAFFARGARH
DERA GHAZI KHAN
INDEPENDENT HILL TRIBES
NOTE.
The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India
Surveyed on Scale 4" = 1 mile up to 1879–80
" during 1880–81
Triangulated and Traversed up to 1879–80
Published
Remaining for Survey
The numerals (1) 2 &c. indicate the Sheets of the Atlas on the Scale of 1 inch 1 mile.

Photozincographed at the Surveyor General's Office, Calcutta.

Published under the direction of Lieut: General J.T.Walker, C.B.-R.E.-F.R.S., *Surveyor General of India.*

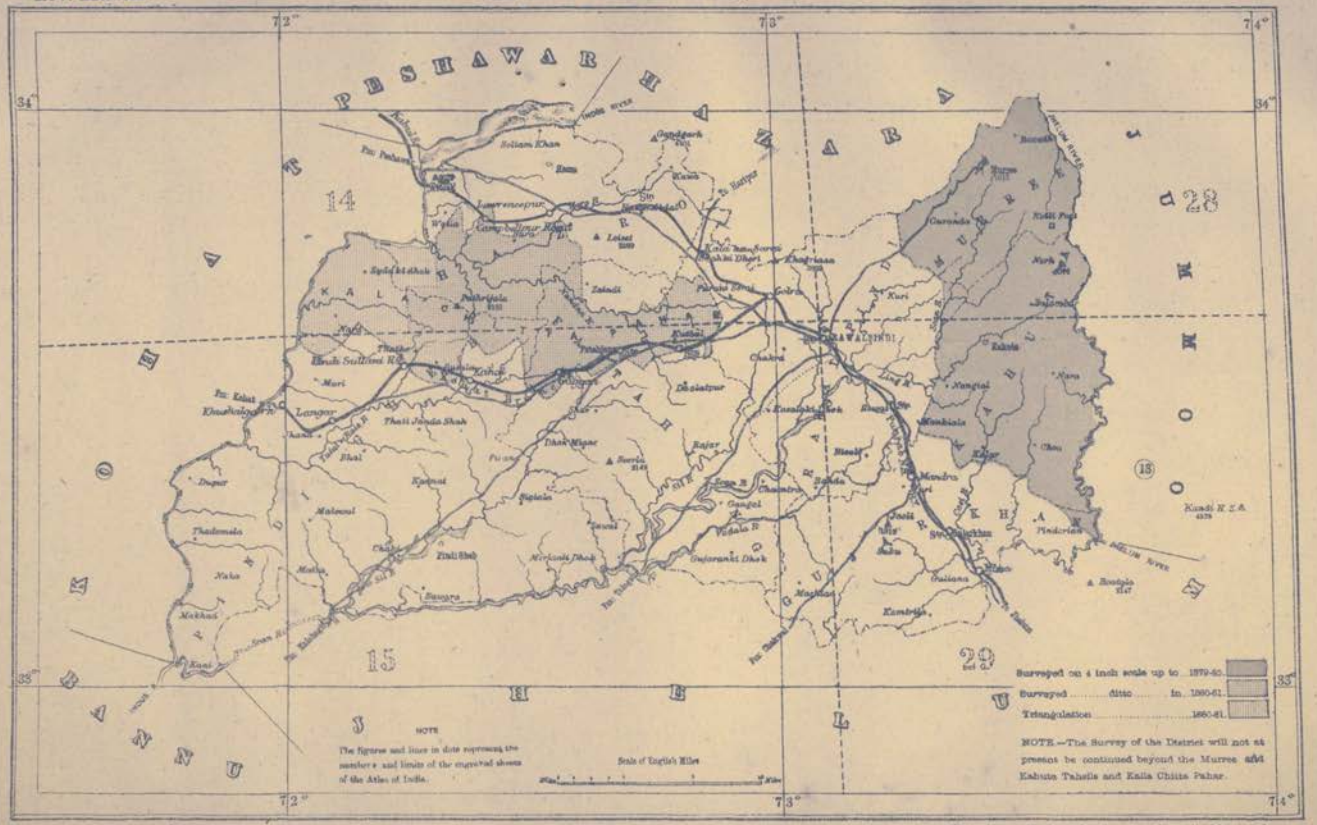
Surveyor General's Office, Calcutta, December

1881

No. 1 PARTY.
Rev. Branch.

PUNJAB SURVEY

INDEX MAP OF RAWALPINDI DISTRICT.



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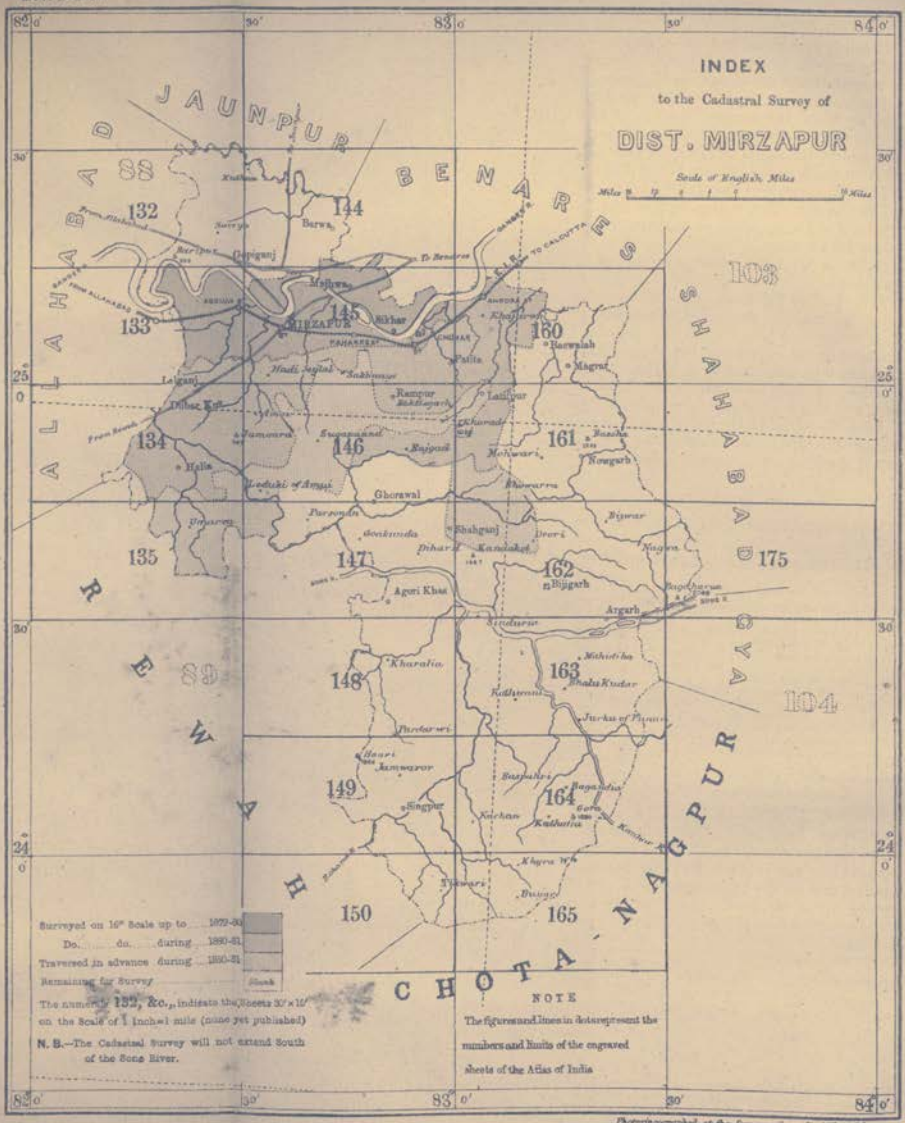
Surveyor General's Office, Calcutta, December
1881

No. 5 PARTY.
Rev. Branch.

N.W. PROVINCES SURVEY


INDEX
to the Cadastral Survey of
DIST. MIRZAPUR
Scale of English Miles
JAUNPUR
BENARES
ALLAHABAD
REWAH
CHOTA NAGPUR
MIRZAPUR
Surveyed on 16" Scale up to 1872-80
Do. do. during 1880-81
Traversed in advance during 1880-81
Remaining for Survey
The numbers 132, &c., indicate the Sheets 30'×15' on the Scale of 1 inch=1 mile (none yet published)
N. B.—The Cadastral Survey will not extend South of the Sone River.
NOTE
The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India

Photozincographed at the Surveyor Generals Office, Calcutta.

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Surveyor Generals Office, Calcutta, December 1881

Leveling operations had been carried on over the Dera Ismail Khan in 1874-75, and 64 of the old bench marks fixed during those operations have been identified and are shown on the maps.

The maps of the District which are drawn in the office of the party are on the scale of the survey, that is, 4 inches to the mile. Of these, 59 have been completed during the season, and manuscript copies of them have also been prepared for use in the District Office. The maps of the District for publication on the 1-inch scale are being prepared in Calcutta.

112. The survey of the military Camps in the Hazara District has been based on the old triangulation of the District, executed in 1865-69, but many new points had to be added on account of the large scale—12 inches to a mile—required for the maps of the Camps. The maps, five in number for the seven Camps, have all been photozincographed, and copies supplied to the Military Department.

113. During the recess, the drawing of a series of maps of the estates in Murree Sanitarium, and of another series of the Murree Bazar, the survey of both of which had been carried out some years previously by Colonel H. C. Johnstone, at the expense of the Murree Municipality, was completed, and the maps have been delivered to the Municipality.

This party will complete the work allotted to it during the current field season, and will be ready to take up work in a new district in October 1882.

114. The office of the party was inspected by the Deputy Surveyor-General in September, who expresses entire satisfaction with Colonel Macdonald's management of the field establishment and with the control he exercises over his office.*

CADASTRAL OR FIELD SURVEY.

XVIII.—MIRZAPUR DISTRICT, NORTH-WEST PROVINCES (No. 5 PARTY, REVENUE BRANCH).

115. This party resumed field operations in District Mirzapur, under the control of Colonel F. C. Anderson, on the 1st November 1880, and remained in the field in that District until 8th April 1881. The tract surveyed in Mirzapur embraces the low-lying parganas of Ahraura, Bhagwat, Bhueli, and Chunar in the Gangetic Valley, and also portions of the up-lands of the District included in parganas Ahraura, Bhagwat, and Kantit. A detachment of the party was also employed from January to April in the Tarai District of the Kumaun Division, where a cadastral survey of certain villages had been asked for by the Government of the North-West Provinces. This detachment suffered severely from fever, and had to be withdrawn from the field earlier than was intended. The following table exhibits the area completed in both Districts, the surveys being entirely cadastral and on the 16-inch scale :—

Personnel.

Colonel F. C. Anderson, Deputy Superintendent, 1st grade, in charge.
Mr. C. W. Campbell, Surveyor, 1st grade.
„ E. G. Little, Surveyor, 4th grade.
„ R. B. Smart, Assistant Surveyor, 1st grade.
„ T. F. Freeman, „ 1st „ on sick leave from 1st May 1880.
„ T. Shaw, Assistant Surveyor, 1st grade, transferred from Garo and Goalpara boundary survey from 1st November 1880.
„ E. P. S. Hill, Assistant Surveyor, 2nd grade.
„ P. C. H. Smart, Assistant Surveyor, 3rd grade, transferred to No. 6 party from 1st September 1881.
24 Sub-Surveyors, &c.

Temporary Establishment.

251 Field Surveyors and others

District.	Number of villages.	Area in square miles.
Mirzapur	978	636·98
Tarai	20	27·99
TOTAL . . .	998	664·97

* Lieutenant-Colonel Macdonald reports as follows on the services of his Assistants :—

Mr. G. B. Scott worked hard during the field season, and during the recess months when he surveyed the Hutted Camps single-handed. Mr. Buttress is a very steady, reliable, and hard-working Assistant. Mr. Gibson is a good hill Surveyor and Draftsman. He took great pains in visiting and instructing the men under his charge in hill surveying. Mr. Kelly is a steady and painstaking Assistant.

The following Sub-Surveyors are brought to notice as having worked well, *viz.*, Elahi Bux, Ramtonoo, Eed Mahomed, Goordit Singh, and Abdool Aziz.

The preliminary traversing of a further area of 540 square miles in District Mirzapur has also been done in readiness for the cadastral survey of next season.

116. Regarding the adoption of the 16-inch scale for the entire area which has been surveyed in the Mirzapur District, Colonel Anderson reports as follows.—

"It was originally proposed that all village boundaries in the up-lands of the Mirzapur District should be plotted on the 16-inch scale, that the cultivated portions of villages should be shown on the same scale, and that the uncultivated area should be taken up on the 2-inch scale. The proposition was made on the supposition that there were large tracts of waste in the Upraudh Tappa and in the up-lands generally. It was, however, found in the course of survey that no such extensive waste lands existed, and that the uncultivated area lay mostly in narrow isolated strips, which it was easier to show on the 16-inch sheets, that had with these exceptions been already completed, than to survey them separately on the 2-inch scale which would necessitate the making of fresh plots."

117. The season's operations presented exceptional difficulties owing to the predominance of rice lands, where the "fields" are sub-divided into "*kiaris*," or beds for irrigating purposes. The ridges of these interior sub-divisions are the same in appearance as the ridges that enclose the fields; hence, in the absence of the cultivator, whose presence could not always be obtained without great loss of time, it was found to be desirable, in some cases where the scale admitted of it, to survey *kiaris* as well as "fields." The number of fields or separate parcels of land which have been surveyed is 613,692.

118. There were many unsettled boundary disputes when the party took the field. In most of these cases, the zemindars declared their unwillingness to accept any boundaries but those of the Revenue Survey of 1839-40; and the restoration of these boundaries, which the Deputy Collectors of the District found themselves unable to perform, was carried out, when applied for, by Colonel Anderson's surveyors.

119. The stations of the traverse survey have all been marked by specially cut stones, and, whenever practicable, the stations were placed on the actual boundary lines, so that the stones should serve the double purpose of marking, permanently, certain points of the village boundaries as well as the stations of theodolite observations. The cost of the stones, which are also village boundary marks, is paid for by the zemindars, and the cost of those not on the boundary is included with the expense of the survey.

120. Eleven stations of the Trigonometrical Survey have been incorporated with the measured traverses, and comparisons have been instituted between the trigonometrical values and the measured distances of 21 rays, with the result that the average error of the measurements is found to be 1·4 feet per mile, varying from 3 feet per mile, which is the greatest error, to 0·1 foot per mile. The heights of 19 traverse stations on the first step of the Vindya Range have been determined by means of vertical angles observed to and from a Trigonometrical Survey principal station. Check surveys to the extent of 1,710 linear miles, partly by the European Officers and partly by Native Inspectors, were measured to test the accuracy of the 16-inch survey. The results are said to be most satisfactory.

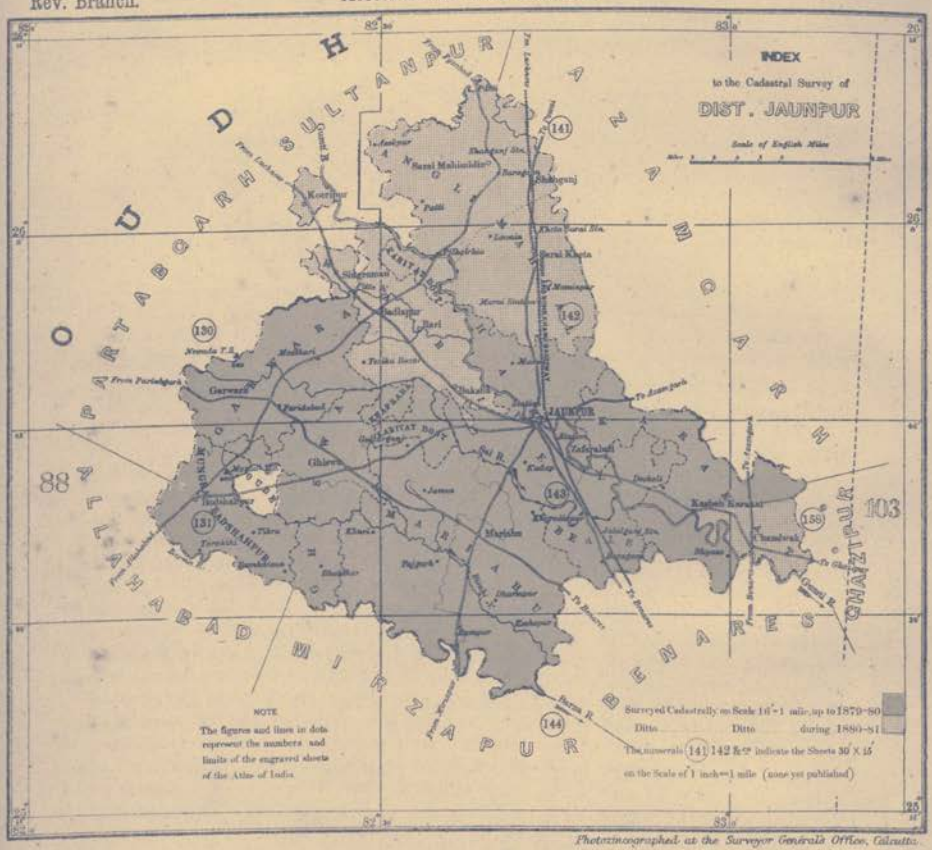
121. The season's outturn in Mirzapur has been mapped on 1,092 sheets on the 16-inch scale. These have been drawn and are all ready to be printed, with the exception of 135 sheets on which there are boundary disputes. Of the previous season's work, there are still 29 sheets kept back, also owing to disputed boundaries. The general maps of the Mirzapur District are under compilation, 12 sheets having been partially drawn. The villages surveyed in the Tarai are mapped on 40 sheets.

122. All the cadastral maps of the Banda District have now been drawn, many of them having entailed much labour in depicting hill features on the large scale of 16 inches to the mile. Of the general maps of this District, on the 4-inch scale, 47 have been completed during the season, and 25 remain, which are partially drawn.*

* Colonel Anderson reports that the European officers have, without exception, worked well, Messrs. Campbell, Little, and R. B. Smart being specially mentioned.

No. 6 PARTY.
Rev. Branch.

N.W. PROVINCES SURVEY



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Surveyor General's Office, Calcutta, December
1881

XIX.—DISTRICT JAUNPUR, NORTH-WEST PROVINCES (No. 6 PARTY, REVENUE BRANCH).

123. Throughout the year this survey has remained under the charge of Mr. E. T. S. Johnson. Field operations were resumed on the 20th October, and were continued up to 5th April, when they were brought to a close on the completion of the District. The area surveyed cadastrally on the 16-inch scale is as follows:—

Personnel.

Mr. E. T. S. Johnson, Deputy Superintendent, 3rd grade, in charge.
Mr. P. A. G. Cowley, Surveyor, 2nd grade.
„ J. S. Pemberton, „ 3rd „
„ J. S. Swiney, Assistant Surveyor, 1st grade.
„ E. J. Martin, „ 1st „
„ E. H. S. Gasper, „ 3rd „ transferred to Akyab waste land grants survey from 1st November 1880.
„ C. S. Kraal, Assistant Surveyor, 3rd grade.
„ P. C. H. Smart, Assistant Surveyor, 3rd grade, transferred from No. 5 party from 1st September 1881.
24 Sub-Surveyors, &c.

Temporary Establishment.

189 Field Surveyors and others.

Parganas.	Number of villages.	Area in square miles.	Remarks.
Chandwak	100	42·60	
Pisara	15	3·96	
Rori	231	102·53	
Chanda	80	33·84	
Karyat Mendha.	71	19·52	
Haveli	2	0·58	
Ungli	540	267·80	
Total	1,039	470·83	

Four outlying villages of Oudh, in area 0·72 of a square mile, falling within the Jaunpur District, were surveyed topographically.

The survey of the Jaunpur District was commenced on 1st December 1877, and has thus occupied four survey seasons. The whole District has been surveyed by Mr. Johnson, who deserves credit for the manner in which he has conducted the operations and completed the records.

124. The cadastral survey during the past season has been carried out without any field books being kept, the measurements being plotted direct on the 16-inch maps. Mr. Johnson states that the surveying progressed faster without field books than under the former system, and he says that the check surveys showed that the work was very good; but he is not entirely in favour of the change of system. The check surveys, measured partly by European and partly by Native agency, amounted to 1,998 linear miles. In order to avoid delay to the Field Surveyors, had they to await the attendance of cultivators to point out the boundaries of "fields," these boundaries were demarcated under the orders of the Collector; and by this demarcation the survey of many subordinate plots of the "fields" in irrigated rice lands has also been avoided. The number of fields which have been surveyed is 881,912, of an average area of 0·34 acre. The stone pillars to mark village tri-junctions were not all fixed at the beginning of the season in readiness for the commencement of the traverse survey, which is so desirable, but they are said to have been put in subsequently. Certain selected theodolite stations have been marked by the survey Establishment with burnt clay cylinders; and the maps show the stations which have been selected for these marks.

125. Before quitting the field, Mr. Johnson, at the request of the Settlement Officer, detached an Assistant Surveyor and two Sub-Surveyors to select suitable positions for permanent pillars to mark the boundary between Jaunpur and the Province of Oudh. The Surveyors selected 1,375 new points, in addition to 651 other existing permanent marks, all of which were pointed out to subordinate revenue officials deputed to receive charge of them.

Mr. Johnson acknowledges the very great help he received from the Collector of the District, Mr. J. C. Williams, in the matter of village labour during the season.

126. The out turn of the season is mapped on 1,008 sheets on the scale of 16 inches to a mile, and all but a few sheets on which there are disputed boundaries have been lodged in Calcutta. The general maps of the District, which have been prepared by reduction from the cadastral survey, consist of 23 standard sized maps on the 2-inch scale. These are all nearly ready for publication.

127. The cadastral section of the Establishment will now cease to exist, and the greater numbers of the members of the section have been discharged. A small detachment will, however, be employed for one season on the survey of a few villages in District Sylhet to test the accuracy of the Mehalwar maps. The breaking up of this cadastral Establishment is much to be regretted. Many of the members had been employed continuously since they were entertained for the cadastral survey of the Agra District, and the Establishment generally was well trained and very efficient.

The permanent or professional section of the Establishment has been transferred to Bengal for the survey of part of the Hooghly River.*

XX.—DISTRICTS GHAZIPUR AND BALLIA, NORTH-WEST PROVINCES (No. 4 PARTY, REVENUE BRANCH).

128. Field operations were resumed under Major Barron's control on the 26th October 1880, and were continued up to the 10th April 1881. The following statement shows the area of cadastral survey on the 16-inch scale which has been completed:—

Personnel.

Major W. Barron, Deputy Superintendent, 3rd grade, in charge.
" H. S. Hutchinson, Officiating Assistant Superintendent, 1st grade, transferred from No. 11 party, joined on 1st January 1881 and transferred to Darjeeling Survey with effect from 1st April 1881.
" W. A. Wilson, Surveyor, 3rd grade.
" H. T. Hunby " 4th "
" W. C. Price " 4th " transferred from G. T. Branch from 1st October 1880, joined on the 28th idem.
" S. O. Madras, Assistant Surveyor, 1st grade.
" W. D. Corbett, " "
" E. B. M. Drew, Assistant Surveyor, 3rd grade, restored to full pay list, with effect from 1st April 1881, and joined from No. 5 party on the 14th April 1881.
" L. F. Berkeley, Assistant Surveyor, 3rd grade.
31 Sub-Surveyors, &c.

Temporary Establishment.

183 Field Surveyors and others.

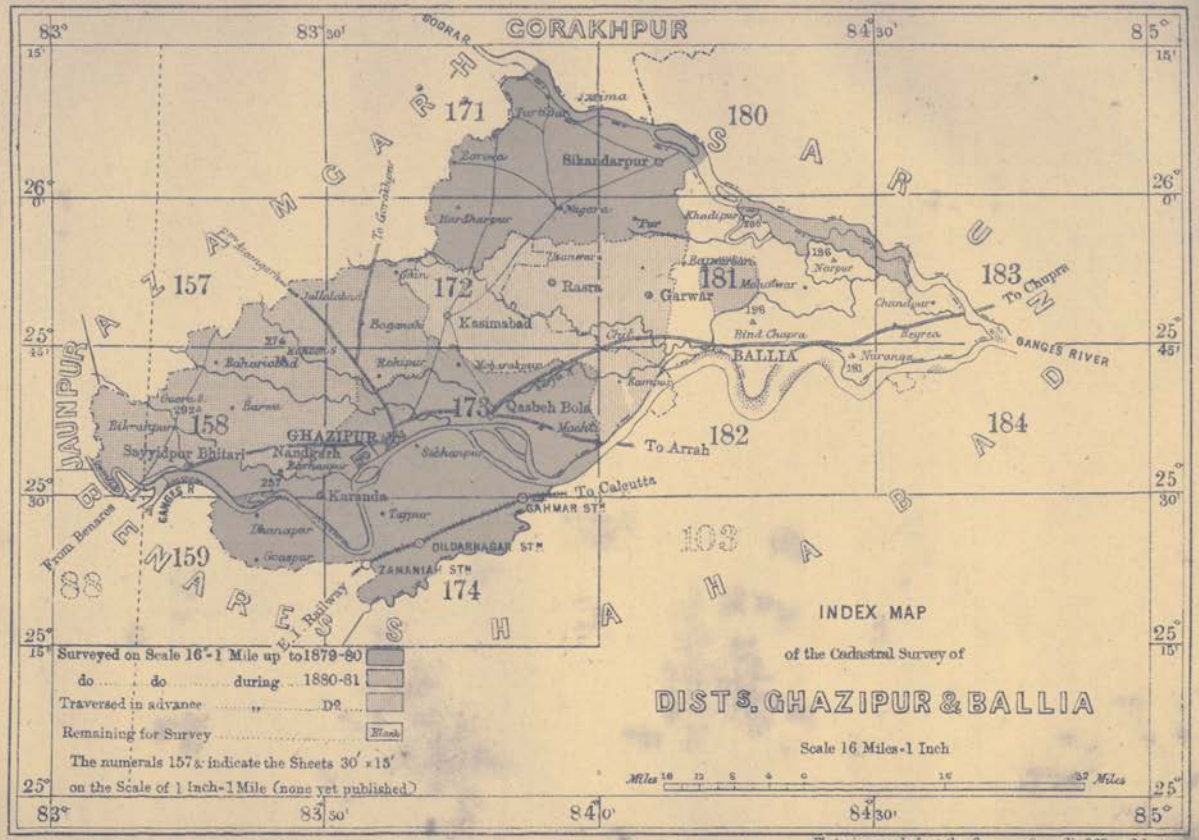
District.	Pargana.	No. of villages.	Area in square miles.	Remarks.
Ghazipur	Sayyidpur Bhitari	386	123·42	
	Khanpur	93	36·47	
	Bahariabad	173	55·62	
	Shadiabad	528	177·66	
	Pachotar	231	119·71	
	Zahurabad	28	13·29	
Ballia	Kharid	68	64·16	
	Ballia	18	15·14	
	Total	1,475	605·47	

In addition to the above, 18·61 square miles of the Ganges and Gogra Rivers beyond the district boundaries have been added to the cadastral maps; and an overlap, on the 2-inch scale, of 42·57 square miles in the adjoining Districts

* Mr. Johnson highly commends Messrs. Cowley and Pemberton for their efficient management of the sub-divisions of the Establishment entrusted to their charge. Mr. Swiney also had a small sub-division under him which he managed very satisfactorily. Messrs. Martin and Kraal are also very well reported on; and the following Sub-Surveyors and others are mentioned favourably, *viz.*, Mr. C. Rivett, Radha Madhub Mitter, Gurupershad Chuckerbutty, Awaz Alli, Tajjudin, Mohan Singh, Shimbhonath, Kanhia Lall, and Gholam Hyder Khan.

No. 4 PARTY.
Rev. Branch.

N. W. PROVINCES SURVEY.



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NOTE

The figures and lines in dots represent the numbers and limits of the engraved sheets of the Atlas of India

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Surveyor Generals Office, Calcutta, December
1881

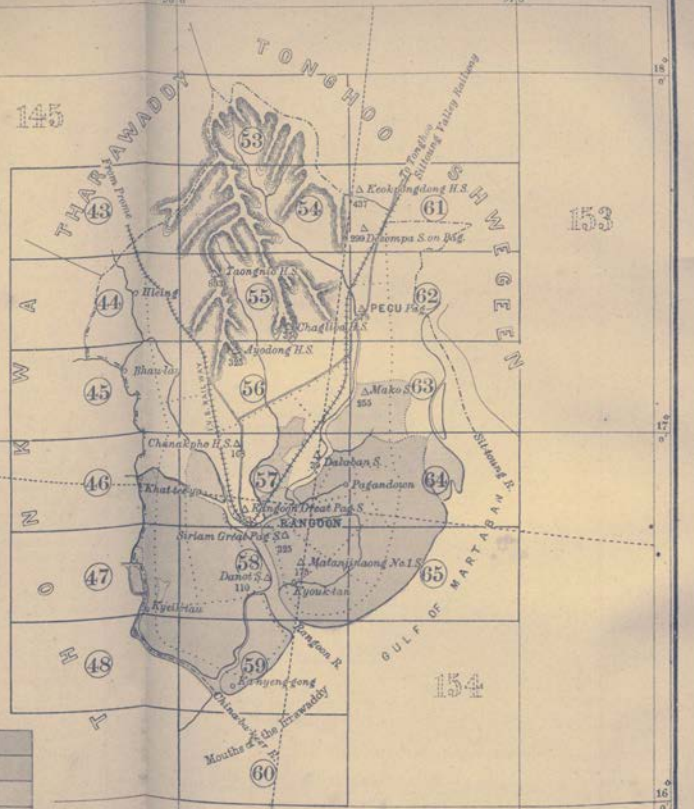
No. 2 PARTY.
Rev. Branch.

BRITISH BURMA SURVEY

INDEX MAP
OF THE CADASTRAL SURVEY
OF
DIST HANTHAWADDY

Scale of English Miles

Miles 10 15 0 5 10 20 30 Miles



Surveyed Cadastrally on Scale 16 = 1 Mile up to 1879 80

Do Do during 1880-81

Do on 2" inch Scale Do 1880-81

Traversed in advance Do 1880-81

Lines of Level are shown thus

The numerals 43 44 &c. indicate the Sheets 30 X 15 on the Scale of 1 inch = 1 mile. (none yet published.)

NOTE

The figures and lines in dots represent the numbers and limits of the Engraved sheets of the Atlas of India.

Published under the direction of Lieut-General J. T. Walker, C.B. R.E. F.R.S., Surveyor General of India.
Surveyor General's Office, Calcutta, December 1881.

Photozincographed at the Surveyor General's Office, Calcutta.

of Benares and Azamgarh has been surveyed. Preliminary traversing in advance for the cadastral survey of next season has been carried out over an area of 415 square miles. The number of fields falling within the cadastral area is 918,740, the fields having an average size of 0·42 of an acre.

129. The area surveyed in District Ballia consists of two separate portions detached from the area surveyed in Ghazipur. One portion includes the large lake known as "Tal-Suraha" and its surrounding villages, and the other is a tract of country embraced between the Bahera Nala and the Gogra River. Both portions were surveyed before their regular time, in accordance with the wishes of the Government of the North-West Provinces, as a large revenue was being lost on account of unassessed accreted lands. Owing to the water of Tal-Suraha not subsiding as usual, the survey of that portion could not be completed until July. These detached surveys have somewhat affected the season's out-turn, and have also added to the expense.

The general system of the cadastral survey was the same as during the previous season, and the measurements of the fields were plotted direct on the maps without any record of them being kept in field books. Major Barron again reports greatly in favour of the abolition of the field books; and he states his belief that the out-turn of his party would have been less by over 150 square miles, had the old system been in force. The field measurements were verified by constant inspections of the work of the Field Surveyors on the ground by the Deputy Superintendent and his European Assistants, and by 1,581 linear miles of check surveys.

Good progress has been made during the year by the Settlement Authorities in placing stone pillars where they were wanting at the triple junctions of village boundaries. All the theodolite stations have been marked by the survey Establishment with burnt clay cylinders.

130. The cadastral area has been mapped on 1,140 sheets, of which 839, on the 1st October, had been sent to Calcutta to be printed. The area books of the villages corresponding with the sheets had been sent simultaneously to the Settlement Officer. For the detached portions in District Ballia, manuscript tracings of the sheets, as well as area books, were sent to the Settlement Officer as soon as possible after the completion of the survey. The general maps on the scale of 2 inches to the mile are under preparation, 13 sheets having been partially drawn. The reduction for the Atlas of India is also in progress.

131. In Districts Ghazipur and Ballia there remains for survey an area of 858 square miles. It is probable that 625 square miles will be completed in the coming season, thus leaving 233 square miles for survey in 1882-83.*

XXI.—HANTHAWADDY DISTRICT, BRITISH BURMA (No. 2 PARTY, REVENUE BRANCH).

132. The field work done by this party was carried out under the orders of Major J. E. Sandeman, who held executive charge up to 31st July 1881, since which date, the party has been under the control of Major J. R. McCullagh, R. E., Assistant Superintendent, Field Operations were commenced on 1st December 1880, and continued up to 20th May 1881.

Personnel.

Major J. E. Sandeman, Deputy Superintendent, 3rd grade, in charge up to 31st July 1881, on furlough from 9th August 1881.
Major J. R. McCullagh, R. E., Assistant Superintendent, 1st grade, joined 2nd June 1881, in charge from 1st August 1881.
Mr. F. Grant, Surveyor, 2nd grade.
„ H. Dowman, Surveyor, 4th grade, temporarily detached to waste land grants survey, Akyab, from 1st November 1880.
„ D. A. King, Assistant Surveyor, 1st grade.
„ J. McHatton, „ 1st „
„ Mr. G. E. Parker, „ 2nd „
„ J. Murphy, „ 2nd „
„ B. M. Wilson, „ 2nd „
25 Sub-Surveyors, &c.

Temporary Establishment.

185 Field Surveyors and others.

Leveling.

Mr. F. Rencontre and a Native Assistant.

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* Major Barron brings prominently to notice his satisfaction with the manner in which Major Hutchinson, Messrs. Wilson, Hanby, and Price have conducted their charge of sub-divisions of the Establishment. Messrs. Madras, Corbett, and Berkeley "have as usual proved themselves good Assistants." Mr. Drew and Mr. Taylor are also well spoken of.

Of the Native Establishment, the following are mentioned as deserving of commendation, *viz.*, Jamaluddin, Mahmud Bux, Usjad Alli, Syuddin Ahmed, Gunga Bishen, Lalmohan Gungopadya, Sew Narain, and hospital assistant Zakir Alli.

133. The cadastral survey includes a small area remaining from last season in the Syriam township, nearly the whole of the Angyee township, and part of the Hmawbee township. The separate and total areas surveyed cadastrally on the 16-inch scale are as follow:—

Township.	No. of Kwins.	Area in square miles.	Remarks.
Syriam	3	16·0	
Angyee	457	743·7	
Hmawbee	22	26·9	
Total . .	482	786·6	

In the Syriam township, 59·8 square miles, consisting entirely of jungle land intersected by tidal creeks, were surveyed on the 2-inch scale. The tract under survey embraces also 41·7 square miles of the Rangoon River and 18·9 square miles of the China Bakeer River, but these areas are not included in the statement of the area surveyed cadastrally. Preliminary boundary traversing in the Angyee, Hmawbee, and Pegu townships has been carried out over a combined area of 258 square miles.

134. It is stated at paragraph 123 of last report that the settlement of 432 square miles, out of the 763 square miles surveyed in the Syriam township during the previous season, had been completed. There, therefore, remained of the surveyed area 331 square miles to be examined and settled by the Settlement Authorities. The examination was done with manuscript tracings of the cadastral maps; and after its completion, the survey of revisions, where required, and of additions of new fields, was carried out by a small party of Field Surveyors. The extensions of cultivation in some *kwins* are said to have been very great, and to have caused the chief difficulty in this work. The original maps were then completed and got ready for printing. The area statements were also corrected. Besides the settlement and revision survey work in the Syriam township, the survey during the season under report of 4 circles, area about 150 square miles, in the Angyee township, was pushed on so as to admit of their settlement in the same season. The necessary documents of these circles were got ready and furnished, and the revision survey in them was also subsequently done.

The work in connection with the revision surveys was found to be very heavy, employing the whole time of one Assistant Surveyor with several Draftsmen and Computors during the field season, and of many others during the early part of the recess season.

135. The survey of 15 waste land grants in the Angyee and Hmawbee townships is included in the work of the season.

The survey of the Rangoon Town District, on the scale of 16 inches to a mile, half the expense of which will be paid from provincial funds and half by the Municipality, has been commenced, and about one-third of the field work has been done.

A special survey, on the scale of 32 inches to a mile, of land acquired for the Rangoon water-works, has also been carried out at the expense of the Municipality.

Leveling operations have been carried on over the District, which are reported on elsewhere; see para. 201.

136. The cadastral survey has been tested by 383 linear miles of check surveys, and by examinations of the maps, field by field, carried out by responsible Inspectors of Field Surveyors. The work is said to have been, as a rule, very good, though a few revisions were required. The number of fields which have been surveyed is 359,820. Connections have been made from measured traverse stations to 30 stations of the Great Trigonometrical Survey. Azimuth observations have been taken at 38 traverse stations.

137. Regarding the Burman Surveyors who were employed, Major Sandeman reports:—

"The work of the Burmans was generally quite as good as the Hindustanis. The best work of all was done by a Burman, and the fastest Surveyor was a Burman.

"It is now proved beyond a doubt that Burmans make excellent surveyors, and I am sure a survey could be carried on by Burmese agency, more particularly if the officer in charge knew the language.

"In office during this recess the Establishment almost entirely consists of Burmans.

"Up to date, 47 Burmans, none of whom have done less than one season's field work, and most of whom have done two or three seasons' work, have received "survey office certificates" qualifying them as Surveyors for employment in the supplementary survey."

The withdrawal of the trained Burman Surveyors for employment in the Supplementary Survey is much regretted by Major Sandeman, but he admits the necessity for the measure on account of the importance of the work on which the Supplementary Survey Establishment is engaged.

138. The temporary demarcation of kwin boundaries by the District Authorities previous to survey is said to have been good, also the definition of the garden lands within the kwins where these existed. The permanent demarcation of kwin boundaries was done by the survey Establishment, and consists of burnt clay cylinders placed at theodolite stations not over half a mile apart.

139. The cadastral area has been mapped on 1,113 sheets, of which 213 were corrected after settlement examination and sent to Calcutta during the recess months to be printed. The remaining 900 sheets are retained at Rangoon pending the result of the revision survey. The general maps on the 2-inch scale are nearly ready for the Syriam township, and these will be published, although not filled up to margin, in anticipation of further progress in the survey, as they are much needed for local purposes.

140. In addition to cadastral survey operations in the Hanthawaddy District, Major Sandeman exercised a general control over a survey of the boundaries of Waste Land Grants in the Arakan Division. This survey, the necessity for which had been pressed upon the attention of the Chief Commissioner by the Government of India, was asked for by the Chief Commissioner in his Secretary's letter No. 102-19, dated Rangoon, 25th August 1880. It had for its object the determination of the precise boundaries and areas of the grants, the boundaries of most of which were ill-defined, and of several unknown. The officer who held immediate charge of the Waste Land Grant survey was Mr. H. Dowman, Surveyor, 4th grade, who was detached from Major Sandeman's party and provided with an Establishment, as per margin, chiefly by transfers from survey parties in India. Mr. Dowman reached Akyab on 29th October 1880; his Establishment arrived from Calcutta shortly afterwards, and field operations were commenced on the 9th November. The party remained at work until the end of May, when they were forced to stop by the setting in of the rains.

Mr. H. Dowman, Surveyor, 4th grade, in charge; 11 Sub-Surveyors, &c.

141. The Grants for survey in Arakan are situated as follows:—

Akyab District	75	grants.
Kyouk-Phyoo	8	„
Sandoway	4	„

Of these, 74 grants in the Akyab District have been surveyed, but the rest had to be left to be done next season. The survey dealt only with the boundaries of the grants, no internal topography having been surveyed. Preparatory temporary demarcation of the boundaries had been carried out under the orders of the Deputy Commissioner; but the demarcations cannot be made permanent until a final settlement of the boundaries, depending chiefly on the areas ascertained by the survey, has been made. In anticipation of the probable necessity for revising some of the boundaries, or of running new lines of boundaries to cut off excessive areas, the theodolite stations of the survey have been marked in a more substantial manner than usual. The maps have been plotted on the scale of 16-inches to a mile, and tracings of the maps of the 74 grants which have been surveyed, with area statements, were sent to the

Deputy Commissioner from time to time as the survey and mapping progressed.

142. The office of the party in Rangoon, and one of the camp offices in the Hanthawaddy District, were inspected by the Deputy Surveyor-General during March. All the work was being carried out very systematically, and the result of Major Sandeman's good arrangements is now seen in an inexpensive but most carefully executed survey. Since Major Sandeman's departure, the office work has been carried on most satisfactorily by Major J. R. McCullagh.*

XXII.—BASSEIN DISTRICT, BRITISH BURMA (No. 8 PARTY, REVENUE BRANCH).

143. Major E. H. Steel, Assistant Superintendent, relieved Major D. C. Andrew of the charge of this party on 20th November 1880, and has conducted the operations throughout the season. Field work was commenced on 1st December, and was continued until 25th May, when the party retired to Rangoon for recess work.

Personnel.

Major D. C. Andrew, Deputy Superintendent, 3rd grade, in charge up to 19th November 1880, and transferred to No. 11 party from 1st December 1880.
Major E. H. Steel, Assistant Superintendent, 1st grade, in charge from 20th November 1880.
Mr. H. R. Littlewood, Surveyor, 3rd grade.
„ J. H. O'Donel „ 4th „
„ P. Ford, „ 4th „ died 21st November 1880.
„ T. H. Dunne, Assistant Surveyor, 1st grade, transferred from the late Khorda Estate Survey from 1st November 1880.
„ G. Campbell, Assistant Surveyor, 2nd grade, on furlough for one year, from 22nd September 1881.
„ C. W. J. Ford, Assistant Surveyor, 2nd grade.
„ W. H. D. Ewing „ 3rd „
28 Sub-Surveyors, &c.

Temporary Establishment.

193 Field Surveyors and others.

144. The scale of the survey is 16 inches to a mile, and an area of 562 square miles of cadastral survey on this scale has been completed. Boundary traversing has also been carried over 508 square miles in preparation for the work of next season; and all the theodolite stations in this preparatory area have been marked by the survey Establishment with burnt clay cylinders.

Regarding the area surveyed cadastrally Major Steel reports:—

"This out-turn seems small, but the work was difficult. The cultivation was much scattered in heavy jungle. The fields were small, and in some instances very irregular in shape."

The close intermingling of the cultivation with the waste is shown by the separate areas given by Major Steel of 237 square miles of cultivated land and 325 square miles of waste. The number of fields in the cultivated area is 259,096, and the average size of the field is ·58 of an acre.

145. Besides the original work of the season, the Establishment has also been engaged in correcting and completing the plans of the circles which came under the Settlement Officer's examination. The area examined was 424·5 square miles, of which 245·5 square miles had been surveyed during the previous season, and the remaining 179 square miles was new work. The survey, mapping, and area computations of the latter area were all completed by special request of the Settlement Officer during the course of the field season.

146. Major Steel trained all his Field Surveyors to plot the fields direct on the cadastral plans—a system on which they had not surveyed during the previous season. The system of working without field books is held in much favour by Major Steel; and he reports with regard to the check lines which were measured that "the whole of the field plans, with very few exceptions, stood the test admirably."

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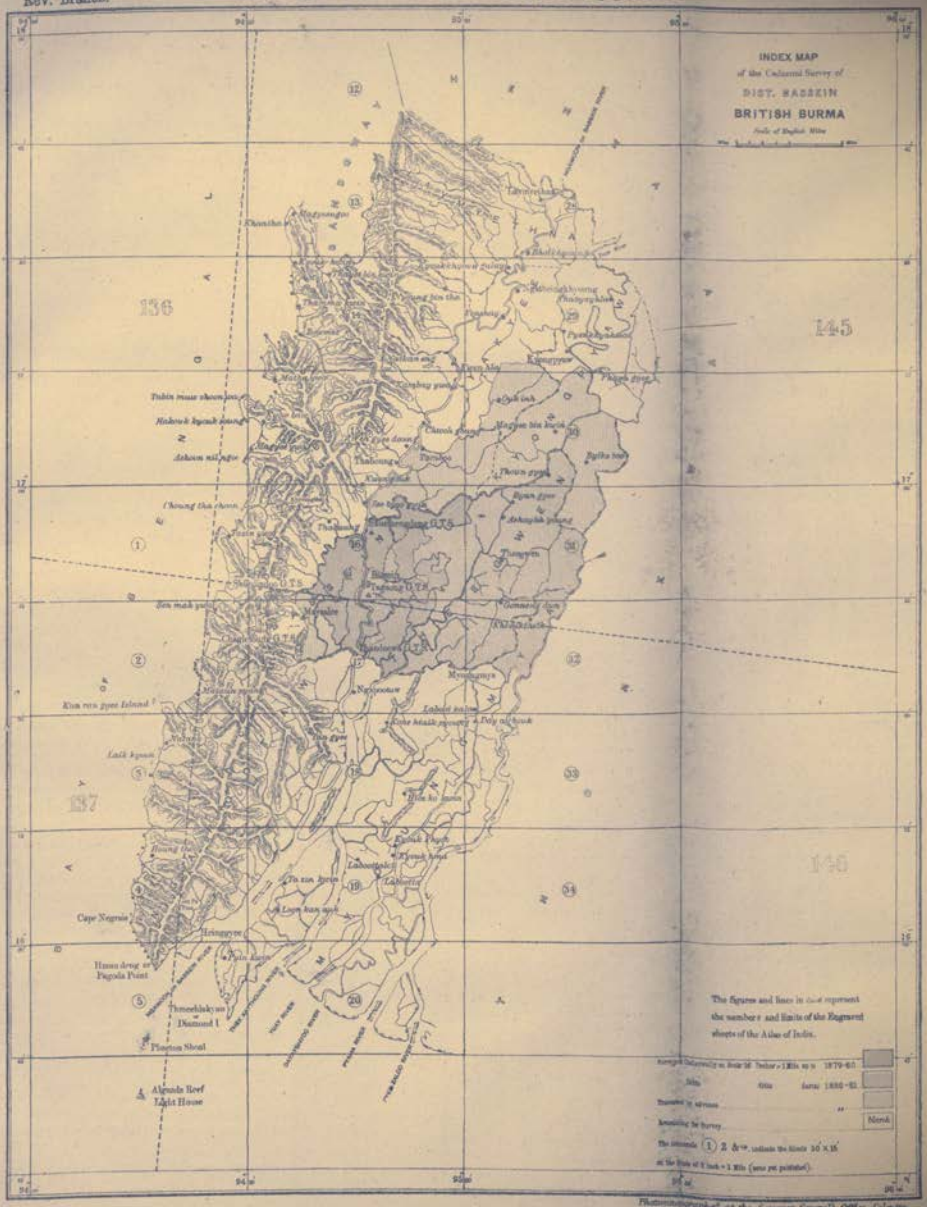
* Major Sandeman reports of his Assistants as follows:—

"Messrs. Grant and King have worked as well as usual and shown great tact in the management of difficult work. I am much pleased, too, with Messrs. McHatton, Parker, and Murphy; they are all willing, hard-working Assistants."

Of the Native Establishment, those who are specially mentioned are:—Oolean Shareef, Mooneekunny, Reedhoy Chunder Das, Bholanath, Hillaludin, Doorgia, Rahmat Ali, and Kadir Bux.

No. 8 PARTY,
Rev. Branch.

BRITISH BURMA CADASTRAL SURVEY



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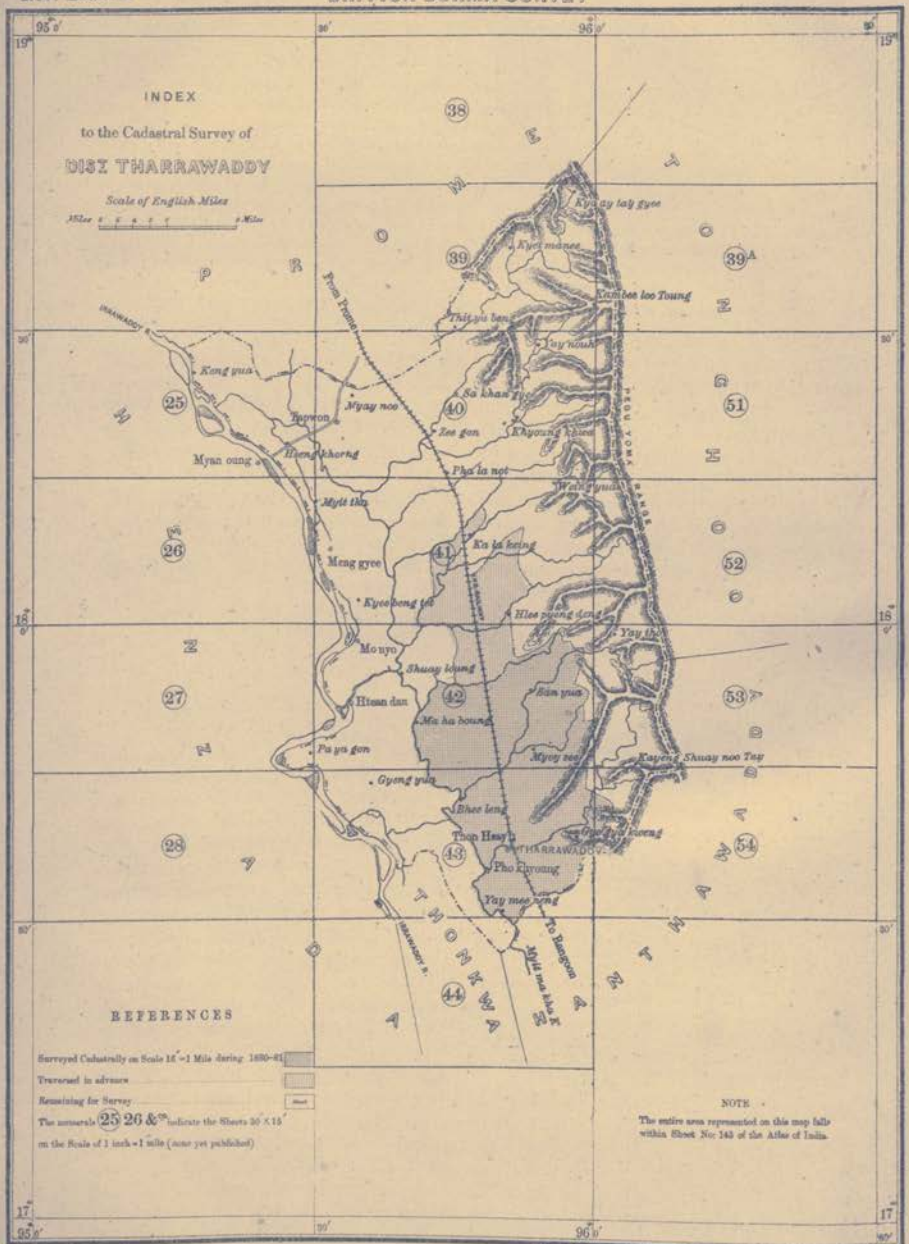
Surveyor General's Office, Calcutta, December

1881

No.7 PARTY,
Rev. Branch.

BRITISH BURMA SURVEY



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Published under the direction of Lieut: General J.T. Walker, C.B., R.E., F.R.S., Surveyor General of India.

Surveyor General's Office, Calcutta, December 1881

147. About one-fifth of the Field Surveyors were Burmans or Karens, who, being beginners, are said to have worked a little slower than the Hindustanis; but it is also reported, "with regard to accuracy, the Karen and Burman, even in their pupil state, do not yield the palm to the Hindustani Surveyors." Major Steel also writes as follows regarding the capabilities of the natives of Burma for survey employment:—

"The Karens and Burmans, as far as a limited experience enables an opinion to be given, possess great capabilities; they are free from all caste prejudices; many more of them than the Hindustanis, in proportion to their actual numbers in the Establishment, know the English language; even when young, they do not come as dull clods to be taught everything, but there is a basis or groundwork of education on which to build up a goodly fabric of survey knowledge. They are quick, docile, and intelligent; on the other hand, they lack 'grit' or stability of purpose, the Burmans perhaps more than the Karens; for this reason they are as yet unfit to take the responsible situation of inspector. The same want of stability is noticeable in office; Burmans are miserable hands at totalling figures; to dash through their work and make a show seems to be their aim. Some few, however, both Burmans and Karens, are beginning to show the effects of careful and steady work: their style and neatness have both improved. Several men also are being taught theodolite work, for which they seem peculiarly fitted."

148. The cadastral maps of all the country that has been examined by the Settlement Officer have been completed and despatched to Calcutta to be printed. The maps of the country not examined, 510 in number, are also completed, but are retained in the Executive Office pending the results of the revision survey. The general maps on the scale of 2 inches to a mile are under preparation.

149. Major Steel's camp in the Bassein District was visited during February by the Deputy Surveyor-General, who expresses himself to have been highly satisfied with the thoroughness of Major Steel in labouring personally to train his men in careful surveying. Major Steel has shown good judgment in the management of the party.*

XXIII.—THARAWADDY DISTRICT, BRITISH BURMA (No. 7 PARTY, REVENUE BRANCH).

150. This party was raised for the cadastral survey of the Tharawaddy District, according to the orders conveyed in letter No. 285, dated 5th August 1880, from Officiating Under-Secretary, Government of India, Home, Revenue and Agricultural Department, to the Chief Commissioner, British Burma. Mr. H. B. Talbot was appointed to the charge of the new party, the permanent establishment of which has been formed partly from the small Establishment which remained of the Khorda survey party, and partly by transfers from other parties in India. For the temporary or cadastral Establishment, Mr. Talbot entertained men who had previously been employed in cadastral surveys in India. For the first season, it was decided to maintain the party at somewhat less than full strength. The party sailed from Calcutta on 29th October, reached Rangoon on 2nd November, and commenced field work in Tharawaddy on 11th November 1880.

Personnel:

Mr. H. B. Talbot, Assistant Superintendent, 1st grade, in charge.
" W. R. Vyall, Surveyor, 4th grade, transferred from the late Khorda Estate Survey from 1st December 1880.
" G. W. Jarbo, Assistant Surveyor, 1st grade, transferred from the late Khorda Estate Survey from 1st November 1880.
" J. R. Scott, Assistant Surveyor, 1st grade, transferred from the late Khorda Estate Survey from 1st November 1880.
" A. W. Smart, Assistant Surveyor, 2nd grade, transferred from Deputy Surveyor-General's Office from 1st May 1881.
13 Sub-Surveyors, &c.

Temporary Establishment.

119 Field Surveyors and others.

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* Major Steel reports as follows of his Assistants:—"Mr. Littlewood's tact, temper, and discretion never fail him. Mr. O'Donel's work is always carefully performed. Messrs. Dunne, Ford, and Campbell have carried on their duties most satisfactorily."

Sub-Surveyors Shaikh Abdulla, Mahomed Massoom, Manohar Lall, Gyasi Ram, and Abdulla Khan, are highly spoken of.

A small area, about 30 square miles, of preliminary boundary traversing had been surveyed during the previous season, which enabled the cadastral survey to be commenced without delay. The survey has been begun in the south of the District, on the boundary of the Hanthawaddy District, and has extended between the Myitma-kha creek on the west and the limits of the forest reserves on the Pegu Yoma Range on the east. Portions of Sanyway and Mongo townships have been surveyed, giving a total area of 461 square miles. Of this area, about 200 square miles are said to be cultivated and about 261 square miles to consist of jungle land. The cultivated area includes 299,673 fields, having an average size of 0·43 of an acre. The preliminary boundary traversing of 205 square miles has also been done in addition to the area surveyed cadastrally. The cadastral survey has been tested by 401 linear miles of check surveys. Azimuth observations have been taken at 41 stations, and 5 stations of the Great Trigonometrical Survey have been connected with the measured traverses.

151. The survey Establishment has also carried out the permanent demarcation of the boundaries of kwins with burnt clay cylinders. These cylinders have been placed at selected theodolite stations of the boundary traverses, and also at a certain number of stations in the interior of kwins to provide for the accurate insertion of the surveys of new cultivation.

152. It being the wish of the Chief Commissioner that settlement operations should be commenced in the Tharawaddy District during the first season of survey, the maps and area statements of one circle were got ready as speedily as possible, and tracings of the maps were delivered to the Settlement Officer. After settlement investigations, the maps were revised, where necessary, and finally completed.

153. Mr. Talbot has not been able to employ Burmans to any great extent during this the first season of the party in Burma, none being available as trained Surveyors; but he has had men under instruction both in field and office work, and next season he expects about one-third of his Field Surveyors will be Burmans.

154. The office of the party in camp at Tharawaddy was inspected during March 1881 by the Deputy Surveyor-General, who expresses himself well satisfied with the work which had then been done, and with the arrangements Mr. Talbot had instituted for managing his party in a country which was new to himself and to all his subordinates.*

* Mr. Talbot reports in very favourable terms of his Assistants, Messrs. Vyall, Jarbo, and Scott, who have been with the party in the field and recess, and of Mr. Smart for the share he has taken in the office work. The sub-surveyors and others who are specially mentioned are:—Nundlall Chatterjee, Jhoona Lall, Issun Chunder Ghosal, Vembally, and Yethnajooloo.

MISCELLANEOUS.

XXIV.—SURVEYS IN THE DARJEELING DISTRICT.

155. The operations of this small party have been restricted during the present year to surveys for new boundary lines, and for the reproduction of old boundary lines of which the original marks were no longer forthcoming, to investigations of boundary disputes, to surveys of tea gardens and other estates, to the combination of the revenue and settlement maps of jotes in the Terai Pergunnahs, to the extension of the survey of the Government cinchona plantation at Sitang, to the combination of the traverses executed by the Forest Department with those of this survey, to running lines of levels on the Lebong spur where the construction of a new cantonment is under contemplation, and—in the central portions of the station of Darjeeling—to surveying and reporting on various boundaries which are disputed, and to completing the general mapping. Captain Harman fell ill in the month of March and obtained leave of absence for three months in consequence; during his absence the charge of the party was held by Major Hutchinson.

Personnel.

Captain H. J. Harman, R.E.
Major H. S. Hutchinson, S. C., Officiating in charge from 8th April to 23rd July 1881.
Mr. W. J. O'Sullivan, Surveyor, 4th grade.
„ W. Robert, Assistant Surveyor, 1st grade.
„ D. J. Collins „ 3rd „
Nabhi Baksh and 3 other Draftsmen.
4 Native Surveyors.
2 Computers and 1 Writer.

156. A large amount of useful work has been done, and a number of maps sent in to the Surveyor-General's Office for publication. Of these the most noticeable are—

(1) The Hill Cart Road, in two sheets (double elephant), scale 4 inches to 1 mile, showing all the water-sheds above the road, the road reserves, and the boundaries of all estates at present bordering the road.

(2) The Hope Town estate, scale 4 inches = 1 mile, in skeleton and with area statements; also hill shaded.

(3) The Hope Town Locations, scale 8 inches = 1 mile.

(4) Government cinchona plantation, two large sheets new survey, hill shaded, scale 8 inches = 1 mile; also, one sheet skeleton reduced from survey of 1874-75 on the 16-inch scale.

(5) Four of the seven large sheets of the skeleton plan of Darjeeling, including Jalapahar and Lebong spur, scale 20 inches equal to 1 mile.

(6) Two large sheets of central portion of Darjeeling, including bazaar, on scale of 40 inches equal to 1 mile, contoured at vertical intervals of 25 feet.

(7) Four large sheets of Darjeeling Hill Station, scale 20 inches equal to 1 mile, contoured at 50 feet vertical intervals, and hill shaded in vertical hachures.

The last is a very admirable specimen of hill drawing, combining the precision of the contour with the pictorial effect and relief produced by hachuring.*

* Captain Harman reports in commendation of the services of Messrs. O'Sullivan, Robert, and Collins, and states that Nabhi Baksh, Draftsman, has worked early and late, and most successfully as well as industriously.

GEOGRAPHICAL.

XXV.—Geographical Operations in Afghanistan.

157. The withdrawal of the British forces from Northern Afghanistan in September 1880 necessitated the return of the survey officers who were employed in that portion of Afghanistan to India with the army. Thus no fresh geographical information has been obtained, since the date of the last report, in the regions around Kabul. But in March 1881 an opportunity was offered of increasing our geographical knowledge of portions of Waziristan, situated on the eastern confines of Afghanistan, contiguous to the British districts of Bannu and Dera Ismail Khan; for two expeditionary columns were sent into that region for purposes of retribution and repression necessitated by recent acts of hostility, and officers of this department were attached to both columns.

158. One column, under Brigadier-General Gordon, C. B., advanced from Bannu up the Khaisar Valley, towards the Razmak plateau, along the northern confines of the country of the Mahsud Waziris, returning through the Shikto Valley to the plains of Bannu. The other column, under Brigadier-General Kennedy, C. B., advanced from Tonk into the southern and western Waziri Valleys, and then proceeded, *viâ* Kaniguram, to the Razmak plateau, and returned, *viâ* Palosin, to Tonk. Major T. H. Holdich, R.E., and Lieutenant the Hon'ble M. G. Talbot, R.E., accompained the first column, and Captain G. W. Martin, S. C., accompained the second.

159. Through the united exertions of these officers—aided by a native surveyor, Imam Bux, who was taken under tribal protection to tracts which were inaccessible to Europeans—an area of about 1,200 miles in and around Waziristan was surveyed in more or less detail, filling up blanks for portions of the country which had not been visited during the expedition of 1860 under General Sir Neville Chamberlain, K.C.B., and reaching beyond to regions which had never before been seen by Europeans. The survey officers were able to ascend several mountains on the western frontier, including the celebrated peaks of Pirghal and Shuidar, which are 11,000 feet high, and command an extensive view of the region lying to the east almost up to the principal roads from Quetta to Ghazni. Fortunately the atmospheric conditions were most favourable for distant vision, enabling points to be fixed by triangulation up to distances of 200 miles. Thus, though the operations of the surveyors were necessarily somewhat hurried in order to keep pace with the movements of the troops, much valuable information has been obtained which, when combined with a recent rough reconnaissance of the Zhob Valley and the upper branches of the Gomal Valley towards the Ab-istada Lake, by a native explorer, will go far towards filling in the blanks in the maps of that region, and correcting the very inaccurate and, for the most part, conjectural information which has hitherto been accepted for want of anything better.

160. The British forces were not withdrawn from Southern Afghanistan until April 1881. Meanwhile Lieutenant-Colonel E. P. Leach, V.C., R.E., assisted by Lieutenant the Hon'ble M. G. Talbot, R.E., and Lieutenant F. B. Longe, R.E., completed some triangulation around and to the north and west of Kandahar, and extended towards the Hazara country, the survey of the Kakrez Valley which had been previously made by Captain Hobday, and also added to the survey of the Argandab Valley. A survey of Kandahar and the surrounding country was made on the scale of 6 inches to the mile by a native surveyor under Lieutenant-Colonel Leach's supervision; it was entirely executed by the plane-table, and covers an area of 65 square miles.

161. The survey operations in Afghanistan having now been brought to a close, it is desirable to state that, during the period which has elapsed since the occupation by British troops in 1879, an area of 39,500 square miles has been surveyed, in more or less detail, in various parts of the country, and a further area of about 7,000 square miles has been explored by native agency. Simultaneously an area of about 7,800 square miles has been surveyed in Beluchistan.

162. During the progress of the survey operations anything in the shape of final mapping was of course impossible; but early publication of all the newly-acquired geographical information being imperative for the requirements of the troops engaged and the Government offices, every map and sketch was reproduced by photozincography as soon as received in the Surveyor-General's Office.* Preliminary compilations of maps of large areas, as those of the Two Routes to Kabul, Northern Afghanistan, Southern Afghanistan, &c., were made in this office, and published as speedily as possible after the receipt of the latest materials, each map passing through two or more editions. The preparation of the final maps has been reserved as far as possible for performance by or under the immediate supervision of the officers who took part in the operations. Those of Northern Afghanistan have been entrusted to Major Holdich, whose report on the preliminary combination and adjustment of the triangulation on which they have to be based is given in the appendix. For Southern Afghanistan, the triangulation north of the parallel of Kandahar has been reduced, and a chart and general report thereof prepared for future reference, while a final map of this region—compiled by Lieutenant-Colonel Leach, V.C., R.E., from all the latest surveys, and combining portions of the surveys executed during the first occupation of Afghanistan—has been published on the $\frac{1}{4}$-inch scale: the large scale plan of the city and suburbs of Kandahar has been fair drawn, with the hills very artistically depicted by Captain Hobday: but the final mapping of the Pishin Valley and other districts of Southern Afghanistan still awaits completion.

* For full details see para. 186 of Annual Report for 1879-80.

163. It may be here noted that one of the broad results of the recent survey operations in Afghanistan is to show that the positions of Kabul, Ghazni, and Kandahar, as indicated on the maps which were compiled after the first Afghan war, are correct in latitude, but erroneous in longitude by 10 to 14 miles, and that they all require to be shifted to the east, bringing them so much nearer to the British frontier. Also that a large number of heights which are entered on those maps are considerably in excess of the truth. They appear to have been mainly derived from barometric observations taken by the celebrated traveller, Dr. William Griffiths, whose skill and accuracy as an observer were eminent and unquestionable. Unhappily he did not live to reduce his own observations, and the method of reduction which was adopted did not take account of the well-known hourly, daily, and monthly variations of barometric pressure, the neglect of which is liable to affect the results very materially. Thus while certain determinations have been found to be very satisfactory, others, and more particularly those in the highlands around Ghazni and Kabul, are materially erroneous, as indicated in the following table, which gives the heights in feet above the sea-level:—

Positions.	As recently determined.	As deduced from Dr. Griffith's observations.
Quetta	5,515	5,537
Kandahar	3,400	3,484
Mukur, lat. 32°51′, long. 67°47′	6,561	7,091
Oba, „ 33°0′, „ 67°56′	6,986	7,325
Ghazni	7,279	7,726
Shashgao, lat. 33°45′, long. 68°32′	8,184	8,697
Shekhabad „ 34°1′ „ 68°45′	6,884	7,473
Kabul	5,780	6,395
Butkak, east of Kabul	5,980	6,218
Khurd Kabul	7,500	7,466
Gandamak	4,500	4,616
Jelalabad	1,950	1,964
Peshawar	1,135	1,068

XXVI.—SURVEYS AROUND GILGIT.

164. The services of Colonel Tanner have been under the disposal of the Foreign Department for the greater portion of this year. But his political duties fortunately lay in and around Gilgit, and he has availed himself of all opportunities which were afforded him of extending his triangulation and prosecuting his geographical researches. He has also supervised the operations of a native surveyor, who had accompanied him as an assistant when he first went up to Gilgit; this man has been latterly employed in completing the survey of Gilgit, and extending it into the Astor country towards the chief passes which lead into the Indus Valley on the one hand, and into Kashmir on the other; and also in correcting and adding to the rough survey of a portion of the Kishengunga Valley, which was made very rapidly and with an inadequate staff of surveyors in 1858 during the mutinies. Colonel Tanner has drawn up an interesting account of the physical features of portions of the scene of the year's operations, which is given *in extenso* in the appendix.*

TIDAL AND LEVELING OPERATIONS.

XXVII.—THE TIDAL OPERATIONS.

165. These operations are progressing very satisfactorily, in accordance with the programme for obtaining a systematic record of tidal phenomena on Indian coasts, which was prescribed by the Government of India and is given in Section XI of the General Report on the operations of the Great Trigonometrical Survey for 1876-77. When the last annual report was drawn up, self-registering tide-gauges had been set up and were in operation at fourteen points, as follows:—

Personnel:

Capt. A. W. Baird, R.E., Assistant Superintendent, 1st grade.
Major M. W. Rogers, R.E., Assistant Superintendent, 1st grade, from 21st June.
Mr. W. G. Beverley, Officiating Assistant Superintendent, 2nd grade.
„ G. Belcham Surveyor, 4th grade.
„ T. H. Rendell, Surveyor, 4th grade.
„ E. J. Connor, Assistant Surveyor, 1st grade.
Sub-Surveyors Dhondu Vinayek, Venayek Narayen, and other computers.

Aden.	Paumben.	Elephant Point.
Kurrachee.	Madras.	Amherst.
Bombay.	Vizagapatam.	Moulmein.
Karwar.	False Point.	Port Blair.
Beypore.	Rangoon.	

At each station self-registering anemometers and aneroid barometers had been set up, and verificatory mercurial barometers established, with the exception of Bombay and Madras, where the proximity of meteorological observatories rendered them unnecessary, and Kurrachee which had not been prepared to receive them. During the present year continuous registrations have been made at the whole of the above points; new stations have been established and registrations commenced, at three points on the River Hooghly, *viz.*, Kidderpore, Diamond Harbour, and Dublat on Saugor Island, and new stations have been prepared at Bhaonagar and Negapatam.

166. Captain Baird went to Europe on privilege leave in June, making over the charge of the party to Major Rogers, whom he met for the purpose at Aden when returning from furlough. While in Europe Captain Baird was placed on duty and appointed one of the delegates to the Geographical Exhibition at Venice on the part of the Indian Government. On the conclusion of his duties at Venice he was granted furlough, for one year and 148 days, of which he stood in much need after his incessant and laborious exertions in the organization of the tidal operations and in training his party.

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* Colonel Tanner reports very favourably of the work done by Ahmed Ali, Sub-Surveyor.

Account of the Registrations, &c., at each station.

167. At Aden a few interruptions in the continuity of the tidal record had occurred, which, though fortunately of little importance, showed that the instrument was out of order and required to be thoroughly cleaned and overhauled. This was done in June under Captain Baird's supervision. The barometric registrations have been continuous, but the anemometer was out of order from February to June. The Port Officer, Captain Thyne, has supervised the work of the clerk in charge of the observatory.

168. At Kurrachee the old small scale tide-gauge set up several years ago for Mr. Parker, in connection with the works for improving the harbour, has been removed, and a new gauge, similar to those in use at all the other tidal stations of this survey, has been set up instead, in a new observatory which has been furnished with a self-registering barometer and anemometer as at other stations. The registrations appear to have been fairly continuous, but the clock of the tide-gauge was occasionally out of order. Much and valuable assistance has been rendered by Mr. Price, the Port Engineer, in the construction of the new observatory, the setting up of the instruments, and the supervision of the clerk in charge.

169. At Bhaonagar a tidal station has been commenced at the cost of His Highness the Thakore, by his Engineer, Mr. Proctor Sims. A complete set of instruments has been provided also at the cost of the Thakore, and registrations will soon be commenced.

170. At Bombay there were two short but unimportant interruptions owing to breaks in the float, followed by a stoppage of the clock for a week when under repair. During this week, however, Mr. Ormiston, the Port Engineer, who had kindly undertaken to supervise the operations, employed some persons in taking hourly observations by night and day; thus there was no actual break in the registration of the tidal curves.

171. At Karwar the tide-gauge has acted continuously, but some difficulties have been met with in preventing the pipe communicating with the sea from becoming choked with sea-weed. An arrangement has therefore been made which enables the pipe to be cleaned without stopping the tidal registration. The performances of the barometer and anemometer have been satisfactory. The anemometer has been set up at the light-house; it was somewhat endangered by ants which got into the clock and destroyed the catgut supporting the driving weight. Fortunately the keeper of the light-house succeeded in cleaning the clock and renewing the catgut; he was thus able to re-start the instrument after a very short break in the record.

172. At Beypore the tidal and anemometric registrations have been continuous and most satisfactory; the barometric have been occasionally interrupted owing to the stoppage of the clock of the aneroid.

173. At Paumben there have been a few short and unimportant stoppages in the tidal registration; the anemometer has worked very well; the clock of the aneroid has stopped several times, but on each occasion it was soon re-started.

174. At Negapatam a site for a tidal station was selected by Captain Baird and the Port Officer in January, in a locality where it was expected the station would not interfere with the traffic. The site was, however, visited a few months afterwards by Colonel Sankey, Secretary to the Government of Madras, and Captain Taylor, Master Attendant, who were of opinion that a station erected thereat would interfere with the traffic. Another site has, therefore, been chosen, where an observatory has been constructed. Registrations will shortly be commenced.

175. At Madras the tidal registrations have been continuous and uninterrupted, excepting that twice in November the high water rose to a level a little above, and twice in March the low water fell to a level a little below, the range of the gauge. This shows that the working scale which is adopted for this gauge, and which happens to be the "natural" or full scale, is a little too large for the tidal range, and that a smaller or fractional scale is required

to embrace the extreme range. As, however, the extreme tides occur very rarely and can be otherwise measured, it has not been considered desirable to employ a smaller scale and sacrifice the advantages of the natural scale. Captain Taylor, Master Attendant, kindly exercises a general supervision over the clerk in charge, and has afforded much valuable assistance here and at the other ports under his administration.

176. At Vizagapatam the tidal and anemometric registrations have been most satisfactory; the aneroid barometer got out of order, and had to be sent to Calcutta to be put to rights, thus causing a break of some weeks in the record.

177. At False Point there have been many stoppages. The observatory is erected on a staging of piles in the harbour, opposite Hookey Tolah; the staging, secured by a mass of stone rubble, was constructed by the Department of Public Works, and to outward appearance was sufficiently substantial. The tide-gauge clock, however, stopped frequently, and this was at first attributed to defects in the clock; but latterly it has been ascertained that the staging had subsided several inches and to a greater degree under the clock than elsewhere, which accounts for the stoppages of the clock. Much has been done to strengthen the observatory, and it is hoped that in future all will go on satisfactorily.

178. At Kidderpore a station has been established off the Government Dockyard, near the entrance to the principal dock, the sill of which has long been referred to as a datum for lines of levels in Bengal. The station was constructed on piles, under the supervision of Lieutenant Stiffe (late of the Indian Navy), who has rendered much valuable assistance in the preparation of the observatories here and at Diamond Harbour and Saugor Island. The registration of the tidal curves was commenced on the 22nd March and has progressed very favourably ever since, notwithstanding that the roof of the observatory was blown off during the sudden and very violent gale which passed over Calcutta on the 10th May; the anemometer also weathered the gale; the aneroid barometer was blown down and injured, but was soon repaired in the Mathematical Instrument Department at Calcutta. Kidderpore being now provided with a complete set of the instruments of this Survey, further registrations with the small tide-gauges of the Department of Public Works, are no longer made.

179. At Diamond Harbour a station has been erected and supplied with a complete set of instruments. Registrations were commenced in April and have been maintained with fair continuity.

180. At Dublat, on Saugor Island, a new station has been constructed and equipped. Registrations were commenced on the 23rd April, and have been maintained continuously. Time is signalled from the light-house at Saugor, and the signals are visible from the top of the Refuge Bund in the vicinity of the tidal station, thus enabling the clerk in charge to correct the several driving-clocks whenever necessary.

181. At Rangoon the tidal registrations have been satisfactory throughout the year; the anemometric and barometric registrations have, however, been frequently interrupted. The wharf on which the station is situated has proved to be an objectionable site, as the traffic over it is very considerable and the rolling of heavy bales of goods tends to shake the instruments and affect the performances of the clocks.

182. At Elephant Point the tidal registrations have been frequently interrupted, owing to the pipe connecting the cylinder of the gauge with deep water having given way, and to the frequent deposits of mud at the bottom of the cylinder. The foreshore is being rapidly washed away, and the Government of British Burma have ordered the removal of the telegraphic office, customs-house, and other public buildings to another site further up the river. Arrangements are being made for the construction of a tidal station at the new site, but meanwhile registrations are continued at the first station.

183. At Moulmein the registrations have been fairly continuous, though there have been frequent short interruptions in the performances of the clocks, caused by the shocks of boats bumping against the wharf on which the station

is erected. Captain Bean, Master Attendant, kindly supervises the clerks in charge of this and the next station.

184. At Amherst there have been several stoppages, arising from the necessity of having to scour out the deposits of mud in the cylinder very frequently. The well in which the cylinder is placed had to be deepened, in order to be sufficiently below the lowest tides; this necessitated the removal of the tide-gauge for some months. Registrations were resumed on the 18th July.

185. At Port Blair the tidal registrations have been most satisfactory. The anemometer has been out of order, and a second instrument sent to replace it was injured *en route*. The Port Officer, Mr. Homfray, exercises a general supervision over the clerk in charge, and has been very obliging.

186. The barrels of the tide-gauges are 5 feet in length, and are thus capable of registering, on the scale of nature, all tides of which the amplitudes between extreme high and low water do not exceed 5 feet. Tides of a greater amplitude have to be indicated on a proportionately smaller scale. For this purpose a gear of wheels is supplied with each instrument which enables the scale to be varied at pleasure. At each station the largest scale which can be adopted is employed. The order of scale is as follows:—

Natural.	*One-half.*	*One-third.*	*One-fourth.*	*One-sixth.*
Madras.	Aden.	False Point.	Bombay.	Kidderpore.
Negapatam.	Karwar.	Kurráchee.	Moulmein.	Diamond Harbour.
Paumben.	Beypore.			Dublat.
	Vizagapatam.			Rangoon.
	Port Blair.			Elephant Point.
				Amherst.

187. The measure of success to be obtained in the accuracy of the tidal registrations depends very greatly on the accuracy of the instrumental adjustments for time and height; when the pencil in traversing the paper on the barrel crosses an hour-line, the time should be exactly that of the hour indicated; and when it crosses a height-line, the height indicated should be exactly that of the corresponding height of the sea-level, with reference to the bed plate of the instrument, or to any fixed bench-mark in the neighbourhood. The several adjustments and settings are, of course, made with great accuracy before the registrations are commenced; but this would be of little use if the instruments were not maintained uniformly in exact adjustment throughout the entire period of registration. The clerks in charge are not qualified to take time observations for correcting the clocks, but happily there is a telegraph office at every place where a tidal observatory has been established—with the exception of Port Blair—to which time signals are sent daily from the Madras Observatory; arrangements have therefore been made to correct the clocks of the several self-registering instruments, whenever necessary, by communicating with the adjoining telegraph office. For the general examination of the instruments, Captain Baird has introduced a system of periodical inspections, which result in every station being inspected once or twice in the course of the year, or more frequently if necessary, either by himself or one of his assistants. He has also drawn up a programme of instructions as to the matters to be particularly attended to during these inspections, which cannot fail to bring to light any displacement by settling or alteration in the adjustment of the tide-gauge, or imperfections in the working of the instruments generally. Sometimes a native watchmaker accompanies the inspecting officer for the purpose of repairing and cleaning the clocks. On these occasions any instrument which is found out of order is thoroughly cleaned and repaired, or replaced by another in better condition.

188. The clerk in charge of each observatory is required to send Captain Baird a daily report, which gives the hourly readings of the tidal diagrams, and various items of information regarding the performances of the several instruments, which indicate whether everything has been going on properly. This report is very useful as a check on the vigilance of the observer, and a precaution against the loss of the diagrams in transmission to Captain Baird's office. The paper on the barrels of the tide-gauges is usually taken off once a week; the curves are inked in daily by the clerk in charge whenever he visits the observatory; ink of different colours is used for different days to enable the

curve of each day to be readily identified whenever there is any overlapping, as not unfrequently happens.

189. When the whole of the diagrams for any port have been received in Captain Baird's office, whatever corrections may be necessary to the hour-lines for clock error, and to the height-lines for changes of zero or contraction of paper, are carefully made and marked on the diagrams; then the momentary heights corresponding to the hours are measured and tabulated. These data furnish the basis of the subsequent calculations, all which are performed by the method of harmonic analysis, as described in the Annual Report for the Great Trigonometrical Survey for 1876-77.

190. The calculations are very laborious, but fortunately they can mostly be put into a form for mechanical computation by any intelligent natives who know a little arithmetic and the use of logarithms and multiplication tables. Captain Baird has succeeded in doing this in a most satisfactory manner. By apportioning the different stages of the calculations among different computers and introducing a careful system of checks, an enormous amount of work is accomplished mechanically by very cheap agency.

191. A very large amount of calculation has been performed during the current year with a view to the determination of the tidal constants at the several ports and stations of observation. Registrations, extending over 23 years, in the aggregate for all stations treated, have been completely analyzed and disposed of. The published tide tables for 1882 embrace 15 ports, showing an increase of 7 against the number of ports provided for by the corresponding tables for 1881. Captain Baird's analyses of the several tidal components which have been evaluated during the current year from his own registrations, are given in the appendix to this report as usual. They are followed by an interesting analysis of the Hooghly tides, also by Captain Baird, from observations which were taken at three points on the river—Kidderpore, Fort Gloster, and Diamond Harbour—during the years 1873 to 1878, by officers of the Irrigation Branch of the Department of Public Works in Bengal.

192. A complete set of all the instruments used in connection with the tidal operations on Indian coasts, was sent for exhibition to the Geographical Congress at Venice. They included a tide-gauge, an aneroid barometer, and an anemometer, each self-registering. Diagrams illustrating the performances of the instruments at various Indian ports were also exhibited. The tide-gauge being connected with the Grand Canal, was employed to register the tides in the canal throughout the duration of the exhibition, and was considered a very attractive object. Drawings of the India Office Tide-predicting Machine, which was constructed in London by Mr. Légé, from the designs of Sir William Thomson and Mr. Roberts, and is employed in determining predictions of future tides from the constants calculated by Captain Baird from the registrations of past tides, were also exhibited and explained by that officer to all persons interested in the subject. Captain Baird was awarded a gold medal of the first class in acknowledgment of his services to science in connection with tidal investigations.*

XXVIII.—THE SPIRIT-LEVELING OPERATIONS.

(1.)—THE OPERATIONS EXECUTED IN CONNECTION WITH THE TIDAL OBSERVATIONS.

193. Good progress has been made in the operations which are conducted under the superintendence of Captain Baird, with a view to connecting the several tidal stations at various points on Indian coasts by lines of spirit-levels, and while so doing to connect the collateral bench-marks of the irrigation and other branches

Personnel:
Captain A. W. Baird.
Mr. Belcham.
„ Rendell.
Sub-Surveyor Narsing Dass and 2 recorders.

* The duty of selecting sites at the three new stations on the Hooghly River and constructing observatories at them devolved on Mr. Beverley, who has also rendered valuable assistance to Captain Baird in the reduction of the tidal registrations. Mr. Rendell has done good work in the inspection of observatories, and also in connection with the leveling operations. Captain Baird reports of Mr. Connor that he cannot speak too highly of his hard work; of Dhondu Venaysh, that he is the only one of the sub-surveyors who can be entrusted with setting up the tidal instruments, inspecting the observations and training the clerks in charge; and of Venayek Narayen, that he is most useful and the best of the native computers.

of the Department of Public Works, and thus enable all the more important groups and lines of levels which have been executed in various parts of India to be reduced to a common datum. The line from Bombay towards Madras, which had previously been carried as far as Raichur, was extended to Cuddapah, a distance of about 185 miles, by Mr Belcham, who, falling ill there, was relieved by Mr. Rendell, by whom the line was continued to Madras, 165 miles. Various branch lines were executed to collateral bench-marks. In all 376 miles of line were leveled in accordance with the usual rigorous system of operation, with standard levels and double-faced staves, and by two observers working independently over the same ground and comparing results from time to time: 26 stone bench-marks were newly set up; 44 previously existing bench-marks and 258 permanent points on temples, parapets, bridges, &c., were connected with the main line.

194. The tidal stations at Madras and Bombay have now been connected by a line of spirit-levels carried directly across the peninsula, for the most part in the vicinity of the line of railway. The mean-sea level has been determined very approximately at each of the two tidal stations, and it would appear from the spirit-leveling operations that the mean-sea level is about 3 feet higher at Madras than at Bombay. That there are variations in the general level of the surface of the ocean at different places, so that, if compared with the surface of the spheroid or other geometrical figure which most closely corresponds to the figure of the earth, the surface of the ocean will in some places be above and in other places below that of the figure, is probable enough; and indeed this must certainly happen, whenever the attractive influences of mountains and other irregularities of the earth's surface on the waters of the ocean are not counteracted by deficiencies of density in the strata below the elevated masses. But as the surface of the ocean is everywhere maintained in equilibrium, there can be no flow of water from one point to another; thus there can be no sensible differences of level, though some points on the surface may be materially higher than other points, as referred to a hypothetical geometrical surface, or, say, to the earth's centre. The differences of height, however considerable, must be insensible, because they cannot be measured by instrumental means; for the causes by which they would be produced must equally affect both the spirit-levels of the instruments and the water-levels of the ocean, whenever both are subjected alike to the same influences. Thus if in the present instance the spirit-levels had been carried, without error, along the coast line, from Bombay round *viâ* Cape Comorin to Madras, they must have shown identity of mean-sea level at Bombay and Madras, just as has been met with in the Red Sea and the Mediterranean on opposite sides of the Isthmus of Suez, and in the Atlantic and the Pacific Oceans, on opposite sides of the Isthmus of Panama. And this identity would be obtained even if there were actually a considerable difference of height, as is very possible; for the Western Ghats, and the generally greater elevation of the western as compared with the eastern half of the peninsula, are sources of attraction which, if not counteracted, must raise the mean-sea level at Bombay no less than 31 feet (as computed by Mr. Hennessey, see para. 250) above the mean-sea level at Madras.

195. The spirit-levels, however, were taken across the continent and not along the coast-line; they were carried from Bombay up the short and abrupt ascent to the crest of the Western Ghâts, and then down the long and gentle decline to the east coast. Thus, while subject to the same general attractive influence of the continental masses as the ocean levels, they are also subject to the more proximate influences of local irregularities in the configuration of the ground passed over. The closing discrepancy of 3 feet at Madras is materially greater—both absolutely, and relatively to the distance leveled from Bombay—than any error previously met in the course of the leveling operations of this survey, which have been carried over many thousand miles and tested at a number of closing points and junctions of circuits, and have been conducted with special precautions to guard against errors of all kinds, whether accidental or cumulative. Moreover, a very similar discrepancy, almost identical in sign and magnitude, is stated to have been met with at the close of the railway levels between Madras and Bombay. Thus it has been surmised that the discrepancy may be due to the proximate and local attractions of the hills and table-lands

over which the lines of level were carried, and which must exercise some influence on the instrumental levels, over and beyond the general influence that is exerted alike on both the instrumental and the ocean levels. Problems of this nature have been investigated mathematically by Colonel A. R. Clarke, C.B., R.E., and formulæ for their calculation are given in his recent valuable treatise on Geodesy. Mr. Hennessey has calculated the attractions with these formulæ, making such assumptions as regards the general configuration of the ground leveled over as appeared to be most reasonable and probable; and he has arrived at the conclusion that the leveling operations cannot have been influenced by the proximate and local attractions experienced on the line of operation to anything like the amount of the discrepancy met with.

196. Thus the discrepancy is possibly due chiefly to error in the leveling operations. As the most probable locus of such error was believed to lie in the section over the Ghâts, where the ascents were very steep and the staves were sometimes so close to the leveling instrument that the foot-marks could not be seen in the field of the telescope, that section was re-leveled; but the results of the two measurements were identical. And indeed it seems highly improbable that the discrepancy can be due to any accidental gross errors, seeing the special precautions which have been taken—by the employment of independent operators and instruments, and the use of double-faced staves—to guard against such errors.

197. But it has long been known that all spirit-leveling operations are liable to an accumulation of small errors which, though individually so minute as to be barely appreciable at any single station where the instrument is set up, have a tendency to be repeated at successive stations, and may therefore attain a considerable magnitude at the end of a long line of levels. In the operations of this Survey it is customary to guard, as much as possible, against such errors by various expedients,—such as observing the back staff first at one station and the forward staff first at the next, alternating the direction of operation on successive days, or at least executing half the work of a field season in the direction of the terminus and the other half in that of the origin; invariably setting up the staves at equal distances from the instrument at every station; and tilting the instrument occasionally, to guard against the heating influence of the sun—or the cooling influence of winds—acting on one side more than another, and causing dislevelments which would be frequently repeated if not counteracted, and thus create an accumulation of error. There is, however, a liability to personal misapprehension in reading the bubble of the spirit-level which may tend to produce a considerable accumulation of error on lines of which the general direction is either towards the sun or opposite to the sun. Owing to the level being placed above the telescope, the observer gets a side view of the bubble, refracted obliquely through the thickness of the glass tube, which is not so sharply defined as the look-down view from above. The rim round the bubble, caused by the adhesion of the liquid to the sides of the tube, becomes so prominent that its extremities may be observed instead of those of the bubble. When light falls obliquely and not vertically on the instrument, and either end of the telescope is pointed towards the light, the outer-edge of the rim at the end of the bubble towards the light is more clearly defined than the inner, while at the opposite end of the bubble the inner-edge of the rim is more clearly defined than the outer. Consequently there is a tendency to assume the instrument to be level when in reality the end towards the light is depressed; and though this tendency would probably vary in magnitude with different observers, it is likely to affect all persons more or less. Obviously it is uninfluenced by reversing the direction of operation, though it disappears whenever the direction is at right angles to that of the light.

198. This personal error in reading the spirit-level and setting the instrument would obviously produce a maximum effect on lines of which the general direction is meridional, when the operations are carried on equally before and after noon; when carried on between sunrise and midday, as is more usual in this country, the direction of the line of maximum effect would be south-east by north-west. The result would be apparently to raise the southern stations relatively to the northern ones. Now this has been found to occur in a greater or less degree in all our lines of levels connecting tidal stations, and not only

on the direct line from Bombay to Madras,—to the following extent in each instance :—

(1) From the mean-sea level of the tidal station of Okha, at the entrance to the Gulf of Cutch, to that of Bombay, there is an apparent rise of ·33 feet, length of line 580 miles.

(2) From the mean-sea level of Bombay to that of Karwar, there is an apparent rise of ·93 feet; length of line 530 miles.

(3) From the mean-sea level of Karwar to that of Madras, there is an apparent rise of ·92 feet; length of line 560 miles.

The apparent rise of 3 feet at Madras as compared with Bombay was generated on a line of 730 miles in length; it is thus materially greater in proportion to the length of line traversed than the discrepancies met with on the three other lines. But as all the discrepancies are in the same direction, and all agree in raising the southern points relatively to the northern, it appears possible that all the operations may have been influenced by oblique illumination of the bubbles of the spirit-levels. It is to be noted that Madras is meridionally 400 miles to the south of Bombay, and that an error of level adjustment amounting in arc to only 1″·2, and recurring with the same sign at only one-fourth of the stations at which the instruments were set up—the operations being otherwise errorless—would produce a discrepancy of the magnitude which has been met with.

199. It has been considered desirable to enter very fully into the matter of this discrepancy, because long lines of level so frequently close without any appreciable error that disappointment may naturally be felt at the occurrence of so large a discrepancy as this, and the re-leveling of the entire line may be considered desirable. But the weakest section has already been re-leveled and no error has been detected in it, and this would probably be also found to happen in all the other sections. It is to be remembered that to whatever extent the levels already taken may be influenced by variations of local attraction, or by oblique instrumental illumination, a second measurement over the same ground would be influenced to exactly the same extent by the first cause and somewhat similarly by the second, and therefore would probably close with a similar discrepancy.

200. In the general reduction of the spirit-leveling operations it will be assumed that the mean-sea level, as determined at each tidal station, is the datum to which the spirit-levels should be referred in each instance. Any discrepancies which may be met with on closing a line at a tidal station will be dispersed over the line and treated as errors generated in the leveling operations.

(2.)—The Spirit-leveling Operations in connection with the Revenue Surveys.

201. The operations in the Hanthawaddy District, British Burma, which had been commenced during the previous season, have been continued in the southern portion of the District on the plan as originally proposed. The Syriam and Angyee Townships of the District have thus been traversed with lines of levels at distances about 10 miles apart. In the north-east of the District, there is a single line extending through the Pegu Township to the boundary of the District. For the central portion of the District, the leveling of the Irrawaddy Valley State Railway and the Sittang Valley State Railway has been incorporated with the present operations, and a new line between the two railways forming a circuit has been measured along the Rangoon and Pegu Road. The total amount of leveling in the several series is 494 linear miles; and the number of bench-marks, all of which are fixed on existing objects, such as trees, boundary demarcation marks, pagodas, and bridges, is 487.

202. The datum to which the leveling is at present referred, so as to allow the results of the operations being recorded provisionally on the preliminary topographical maps, is the mean level of the Rangoon River at the wharf at Rangoon, which has been determined by a tide-gauge. On account of the failure of the tide-gauge at Elephant Point, the mean-sea level was not available, but this datum will be adopted for the heights to be recorded on the final maps.

GEODETIC.

XXIX.—ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

203. The electro-telegraphic operations for determinations of differences of longitude had remained in abeyance since the year 1876-77—first, because both the officers employed thereon, Lieutenant-Colonel Campbell and Major Heaviside, took leave of absence on furlough in 1877; and secondly, because, on the return of these officers to duty, their services were required for a time with the British forces in Afghanistan. It was not until the commencement of the present year that the services of both officers again became available for the resumption of the operations.

Personnel.
No. 1 Astronomical Party.
Major W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade.
Mr. J. Keating, Assistant Surveyor, 3rd grade.
,, D. Atkinson, Surveyor, 2nd grade.
Dhondo Balwant Joshi.

No. 2 Astronomical Party.
Lieutenant-Colonel W. M. Campbell, R.E., Deputy Superintendent, 2nd grade.
Mr. J. Bond, Assistant Surveyor, 1st grade.
Baboo Harsukhai, Recorder.

204. The geodetic arcs of longitude between stations of the Great Triangulation, which had been measured in previous years, are as follows:—

1. Madras-Bangalore.	In 1872-73 by Major Herschel and Captain Campbell.
2. Bangalore-Mangalore.	
3. Hyderabad (Bolarum)-Bombay.	In 1875-76 by Captains Campbell and Heaviside.
4. Bellary-Bombay.	
5. Hyderabad (Bolarum)-Bellary.	
6. Madras-Hyderabad (Bolarum).	
7. Madras-Bellary.	
8. Bangalore-Bellary.	
9. Vizagapatam-Madras.	In 1876-77 by Captains Campbell and Heaviside.
10. Vizagapatam-Bellary.	
11. Mangalore-Bombay.	

On the completion of the last of these arcs of longitude between trigonometrical stations in India, the differences of longitude between Bombay, Aden, and Suez, were determined by Captains Campbell and Heaviside. Suez had already been connected with the Royal Observatory at Greenwich; thus the electro-telegraphic connection between Greenwich and India was completed.

205. During the present year the following geodetic arcs have been measured:—

Bombay-Kurrachee.	Jubbulpur-Hyderabad (Bolarum).
Bombay-Deesa.	Jubbulpur-Agra.
Bombay-Jubbulpur.	Jubbulpur-Deesa.
Kurrachee-Deesa.	Agra-Deesa.

The weather was singularly propitious for star observations throughout the field season, and very little delay was caused by cloudy nights. For this reason, and because of various improvements in the signalling arrangements which had recently been effected, the out-turn of work in the number of arcs completed was larger than had been accomplished in any previous season.

206. The eight arcs of the present year, combined with the previous measurement of the arc Bombay-Hyderabad (Bolarum), present four circuits, which close with remarkably small discrepancies, as the following statement indicates:—

CIRCUIT I.

		m.	s.
Bombay-Deesa		2	31·713
Deesa-Kurrachee		20	40·488
Bombay-Kurrachee	deduced	23	12·201
	observed	23	12·161
	Difference		0·040

		m.	s.
Circuit II.			
Bolarum-Bombay		22	48·848
Jubbulpore-Bolarum		5	42·918
Jubbulpore-Bombay	deduced	28	31·766
	observed	28	31·766
	Difference		0·000
Circuit III.			
Bombay-Deesa		2	31·713
Jubbulpore-Bombay		28	31·766
Jubbulpore-Deesa	deduced	31	3·479
	observed	31	3·478
	Difference		0·001
Circuit IV.			
Jubbulpore-Agra		7	42·993
Agra-Deesa		23	20·518
Jubbulpore-Deesa	deduced	31	3·511
	observed	31	3·478
	Difference		0·033

Mean closing error = 0·0185*s*.

207. An attempt was made to maintain the pendulums of the astronomical clocks in an invariable condition throughout the season, with a view to determining the variations of gravity at the several stations from the changes of clock-rate. It was found, however, that the form of construction of the pendulums did not permit of the maintenance of invariability to a sufficient extent to yield satisfactory results. The mean values of gravity-variation deduced from both clocks agreed fairly with corresponding values deduced by the late Captain Basevi with the invariable pendulums of the Royal Society; but the discrepancies between the two clocks were too large to entitle the results to any confidence. Enquiries are being made in England with a view to ascertaining whether pendulums can be constructed for our clocks which will enable them to be employed in measuring variations of gravity as exactly as they now measure differences of longitude; if this can be accomplished, the scientific value of the operations will be greatly enhanced without any material increase of labour or expense.*

* Mr. J. Bond's services, both in the field and during the recess, are much commended.

PART II.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS OFFICES.

208. These offices comprise—

(1) The Surveyor-General's Office.
(2) The Revenue Survey Office.
(3) The Lithographic Office.
(4) The Photographic Office.
(5) The Mathematical Instrument Office.

} All in Calcutta.

(6) The Trigonometrical Survey Office, Dehra Dun.

1.—THE SURVEYOR-GENERAL'S OFFICE.

209. The five offices in Calcutta are still located, as formerly, in different buildings,—the Revenue Survey Office, which is also that of the Deputy Surveyor-General, being at a considerable distance from all the others. A new building, which is under construction to accommodate the Surveyor-General's and the Revenue Survey Offices under one roof, is, however, nearly completed, and it is hoped that the contiguous building for the accommodation of the lithographic and photographic offices will be commenced next year.

Personnel.

Major R. V. Riddell, R.E., } Dy. Supdts.,
J. O. N. James, Esq. } 3rd grade.
H. Duhan, Esq., Personal Assistant.

DRAWING BRANCH.

Drawing and Compiling Section.

Mr. J. F. Baness, Chief Draftsman.
„ J. Peyton, Surveyor, 1st grade.
„ J. A. May, „ 3rd „
„ W. Green, Draftsman.
„ J. R. Adels, ditto.
Munshee Sonaullah, ditto.
„ Nabi Baksh, ditto.
Mr. J. A. Higgs, Apprentice.
„ J. A. Mu rove, ditto.
„ W. P. Smith, ditto.
„ R. C. Sinclair, ditto.
and 14 Native Draftsmen.

Geographical Examining Section.

Mr. A. Chamarett, Surveyor, 1st grade.
„ W. Todd, „ 2nd „
„ A. J. Wilson, „ „ „
„ F. Adams, „ 3rd „
Baboo M lesh Chunder Shaw,
an 2 others.

ENGRAVING BRANCH.

Mr. C. W. Coard, Superintendent.
„ W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell.
Mr. J. Fulford.
„ T. B. Rogers.
„ A. G. Palmer.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett.
„ E. A. Ollenbach.
25 Native Engravers and 1 Clerk.

Copper-plate printing Section.

Mr. W. T. Collins, Copper-plate Printer.
14 Native Printers and Pressmen, &c.

CORRESPONDENCE BRANCH.*

Mr. T. W. Babonan, Registrar.
„ M. Francis.
„ F. A. D'Rozario.
„ T. E. Ware.
Baboo Banee Madhub Banerjee.
Mr. J. A. Vallis.
Baboo Bheecum Singh,
and 8 others.

Accounts and Miscellaneous Section.

Mr. N. A. Belletty, Surveyor, 1st grade.
„ E. D. Algar,
and 1 Native Clerk.

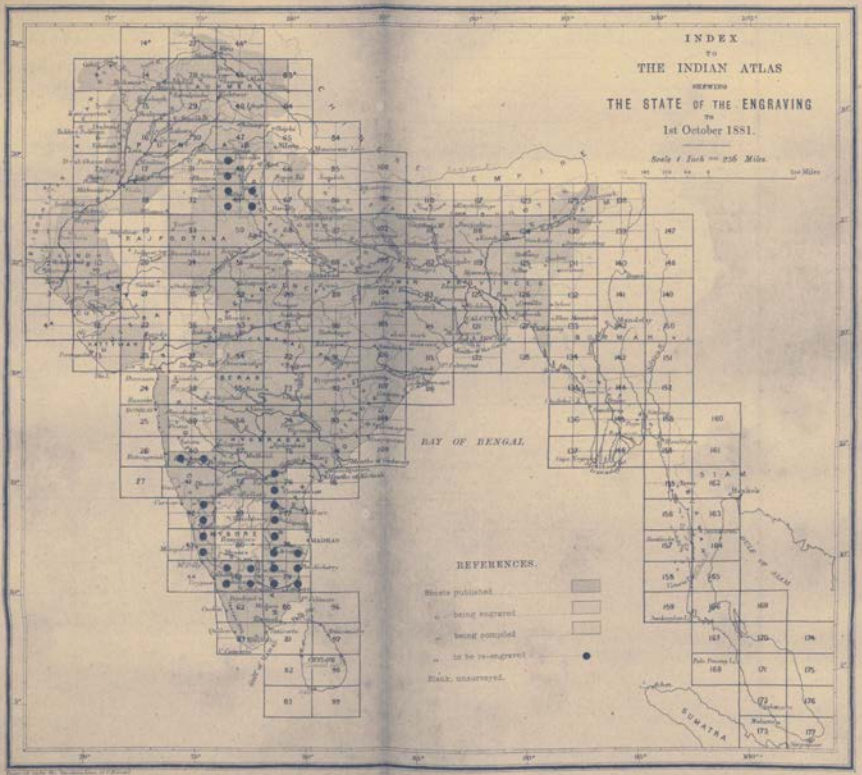
Map Record and Issue Section.

Mr. R. A. Gibson.
„ H. R. Vallis.
„ W. P. Abro,
and 1 Native Clerk.

210. The duties connected with this office are conducted by Major R. V. Riddell, R.E., and Mr. J. O. N. James. Major Riddell supervises the general accounts of the department and much of the detail in connection with the management of the topographical parties, besides having charge of the Lithographic and the Mathematical Instrument Offices. Mr. James has general charge of the Drawing, Engraving, and Map Despatch Offices.

211. In the *Drawing Branch* the work has been of the usual kind, *viz.*, compilations on various scales and from various materials for Provincial and other maps. A map of India on the scale of 1 inch = 32 miles, to replace the old skeleton map on that scale, has been in the hands of the copper-plate engravers for some years and is still far from complete; in order, therefore, to meet numerous demands from Government departments and the general public for a good wall map of India on that scale, it was decided to take prints from the copper-plates as they stood, transfer them to stone, add such names as were

* Mr. Babonau, the Registrar, has performed his multifarious duties, in supervising the general organisation of the office, very satisfactorily. Messrs. Francis and D'Rozario, and Baboos Bani Madhub Banerjee and Bheecum Singh, have also rendered entire satisfaction.



Published under the direction of Lieut.-General J. T. Walker, C.B., R.E., F.R.S., Surveyor General of India.
Surveyor General's Office, Calcutta, December 1881.

desirable, and draw the hills in boldly on the stones, and thus produce a preliminary edition to satisfy immediate requirements. This has been done. The map was completed about the end of the year under review. It was published shortly afterwards, and already a first issue of 500 copies is nearly exhausted; further issues of the preliminary edition, with additions and corrections up to date, will be made from time to time until the copper-plates are completed. The whole of the great Indian mountain ranges, and all the lower hill features in all parts of Hindoostan, have been re-drawn for the engravers who are employed on the final edition.

212. For the map of India on the scale of 1 inch = 64 miles, of which a preliminary edition was lithographed and issued in 1880, the hills have been re-drawn for the engravers. A skeleton edition of this map has been newly drawn with the whole of the names spelt agreeably to the modern orthographical instructions of Government. The hills have been drawn for a new edition of the map of India on the scale of 1 inch = 96 miles; also for two sheets of the new map of Bengal and one sheet of that of Assam, both on the scale of 1 inch = 16 miles. A map of Southern Afghanistan and part of Beluchistan on the scale of 1 inch = 4 miles, and one of the assigned districts of Pishin and Sibi, on the scale of 1 inch = 8 miles, were completed. Much progress was made with various other provincial and district maps, and a large number of atlas sheets have been corrected up to date from the results of the latest surveys. Full details are given in the usual statement of work in the appendix.*

213. The *Examining Branch* has done good service in the careful examination and scrutiny of all the mapping and field work received from the several survey parties, also of the work performed in the drawing office, and of the proofs from the lithographic, photozincographic, and engraving offices; 49 of the standard sheets of the topographical surveys, 28 original compilations and drawings of various kinds, and 424 proofs of engravings, lithographs, and zincographs, have been examined. In addition to this, a large amount of miscellaneous work, including the projection of lines of latitude and longitude, and trigonometrically fixed points and calculations of area, &c., for statistical reports, has been performed.†

214. *Engraving Office.*—The engraving of the standard map of India, on the scale of 1 inch = 32 miles, has been continuously proceeded with during the year under review, and it is hoped that three of the six sheets of which it is comprised will be completed in the next year. The smaller map, on the scale of 1 inch = 64 miles, has also been vigorously pushed on, the more so because the preliminary lithographed edition of this map which was published in 1880 has been in such demand that the stones are nearly worn out: thus the early completion of the engraved edition is very desirable; the names and outlines and much of the hill-etching are now finished, and it is expected that the map will be available for publication by the 1st October 1882.

215. Considerable additions have been made to the copper-plates of the map of India, on the scale of 1-inch = 96 miles, and to those of the district maps of Bengal, Assam, the Central India Agency and Rajputana, all on the scale of 1 inch = 16 miles. The hills have been etched on the plates for the Central Provinces. A chart of the Indian Ocean, to illustrate the system of lighthouses along the coast-line and for the report on wrecks, was completed and published. Nine new sheets of the Indian Atlas, *viz.*, 12 S.-E., 33 N.-W., and S.-W., 35 S.-E., 36 S.-E., 66 N.-E. and S.-E., 86 S.-E., and 131 N.-E., were completed and published; large additions from new surveys were made on 32 plates and small additions on 20 plates. Several of the full size plates which reached this office from England in a nearly worn out state, were partially repaired, and additions and corrections of various kinds were made on 11 of these to bring them up to date. The lines of projection, borders and margins, were completed wholly for 11 new plates and in part for 12 others.

216. The total out-turn of completed work amounts to 1,958 square inches of hill-etching and 2,273 square inches of outline; this does not include repairs of old plates, corrections and additions of railways, canals, boundaries, &c., to a

* Mr. James reports that the Chief Draftsman, Mr. J. F. Baness, has been untiring in his exertions. Messrs. J. A. May, W. Green, and A. Musgrove, Moonshee Sonaulla, and Baboos Radhica Proshad and Gopal Chunder Roy, have done good service. Mr. May is an able hill topographer; zealous, quick, and careful in all his work.

Mr. James Peyton continues to render good aid in hill-drawing both with the brush and pen, and deserves credit for the success with which he has trained one of the apprentices.

† Mr. A. Chamarett, Geographical Examiner, has rendered efficient aid, and his assistant, Mr. A. J. Wilson, has worked zealously and well. The Native assistants, Baboos Mohesh Chunder Shaw and Purna Chundra Sen, have given satisfaction

large number of plates, and miscellaneous work, such as engraving plates for the volumes of the Great Trigonometrical Survey reports, tint ruling, &c.

217. The steel-facing has proved very successful, and in no instance has any plate been damaged. Precautions are of course necessary, and the coating of Brunswick black has occasionally to be removed to permit of the examination of the steel surface, so that if any corrosion has commenced, as is liable to occur during the rainy season, the steel-facing may be taken off at once, which is easily done without detriment to the engraving on the copper. In all 104 large and small sized plates of different kinds were steel faced.

218. In the Copper-plate Printing Branch 7,262 prints of atlas sheets and miscellaneous subjects were taken, 900 proofs were pulled from plates in progress, and 291 transfers were taken for prints to be made at the lithographic and photographic offices. Full details of all the work performed in the engraving branch are given in the appendix.*

219. The Map Record and Issue Section shows no diminution in its work; the map issues have been as follows:

	Maps.	Value. Rs.
To Government officials	42,128	39,877
„ India Office, London	3,074	4,528
„ Agents for sale	5,667	8,613
Total .	50,869	53,014

Applications received for maps by letters, indents, and telegraphic messages	1,533
Letters issued in reply or advice	750
Invoices and receipts issued	1,813
Packets, parcels, and packages despatched . . .	2,340

In addition to the above, 16,664 engraved and lithographed maps were coloured by contract. The amount realized and deposited in the Government Treasury by map sales through agents was Rs. 5,325.

220. The re-arrangement, classification, and cataloguing of the original maps have been steadily progressing throughout the year; 1,280 maps in 5,240 sheets, of various Provinces, Native States and Districts, included in the Bengal Presidency, were grouped according to existing territorial divisions, labelled, numbered and catalogued, and placed in suitable racks which have corresponding numbers ticketed on each shelf to admit of each map being readily found when wanted.†

2.—The Revenue Survey Office.

221. In the Revenue Survey Office, the maps and other records prepared by the several Field Parties of the Revenue Branch are received and disposed of. The office also supervises the expenditure of this branch and keeps its accounts. A summary of the results and cost of the field work of the several parties is given at pages 58 and 59; and tables A and B at pages 69

Personnel.

Lieutenant-Colonel J. Scence, Deputy Surveyor-General, and Superintendent, Revenue Branch.
Major F. Coddington, Deputy Superintendent, 2nd Grade.

Drawing and Computing Branch.

Drawing and Compiling.

Mr. F. W. Kelly, Surveyor and Head Draftsman.
Mr. J. Connor, Assistant Surveyor and Draftsman.
Baboo Hari Har Sen, Head Computer.
„ Tincowry Sen, Computer.
Sheikh Mehir Ally, Draftsman.
„ Golam Mahomed, „
„ Abdul Aziz, „
„ Rohim Bux, „ and fourteen others.

Map examining.

Mr. T. W. Reilly, Surveyor and Draftsman.
Sheikh Abdur Rozak, Draftsman.
„ Wahed Bux, „

Cadastral map examining.

Mr. W. Sinclair, Surveyor and Draftsman.
Sheikh Kodrut Alli, Draftsman, and six others.

Records and Map Issue.

Mr. W. J. Lane, Assistant Surveyor.
Baboo Ashootosh Kur, and one other.

Correspondence and Accounts Branch.

Correspondence.

Mr. A. E. Byrn, Registrar.
„ A. C. Cunningham, Head Clerk.
Baboo Kally Pudo Banerjee, Clerk.
„ Doorga Narain Ghose, „
„ Ramkisto Chunder, „
„ Shama Churn Chuckerbutty, „
„ Jado Nath Mookerjee, Despatcher, and five other clerks.

Accounts.

Mr. Gopal Chunder Laha, Head Accountant.
Baboo Bama Churn Chuckerbutty, Accountant, and two others.

* Mr. James reports that Mr. C. W. Coard continues indefatigable in his labours. The European engravers, Messrs. Donaldson, George Palmer, D. Mitchell, and J. Fulford, have worked very well. The agency secured in India and trained in the office, viz., Messrs. T. B. Rogers, S. M. Coard, A. W. James, A. Coard, A. Chamarett, and E. Ollenbach, bids fair to equal any agency trained in Europe. The Native engravers have all worked well, and the young hands have made good progress.

† Mr. W. Todd, who performs the classification of the original records, has worked well. Mr. Gibson's duties as Map-Curator are very arduous, and his method and energy worthy of commendation.

and 70 of the appendix, exhibit the maps with other records prepared in the Field Offices and Revenue Survey Office, respectively. Table C at page 75 of the appendix, shows the state of the publication of the Cadastral maps.

222. By comparing the summary of the field work with that for last year, it is found there has been a moderate increase of 158 square miles in the area surveyed by the Cadastral Parties in the North-West Provinces, but the increase of 47€,347 in the number of fields has been greater in proportion than the increase in area. The general cost-rate for these parties, which is four annas per acre for the year, is seven pies less than the rate of last year. In British Burma, the area surveyed cadastrally is 701 square miles more than last year, chiefly owing to the addition of a third party, and the number of fields has increased in a larger proportion than the area on account of the smaller fields in the new district. The general cost-rate of this year for Burma, which is six annas six pies per acre, bears a favourable comparison with seven annas three pies, the rate of last year. The area surveyed by the one party now working on mouzawar survey is considerably in excess of what they did last year. Their principal work is being carried on in a very easy country, which accounts for the large area and exceptionally low rate recorded for Dera Ismail Khan. The high rate recorded for Rawalpindi is due to the ground under survey being unusually intricate. The areas surveyed by two of the parties engaged on topographical surveys are very similar to the areas of last year; the third party, No. 10, has found the country in the Konkan to be very intricate, and has not been able to work at the same rate as they did in the Deccan.

223. The following maps drawn in executive offices have been examined and published during the year, *viz.*:—

Meerut Division Topographical Survey .	4 sheets on 2-inch scale.
Ditto ditto .	1 sheet on 1-inch scale. (drawn in 4 sections on 2-inch scale).
Deccan Topographical Survey . .	17 sheets on 1-inch scale. (drawn in 68 sections on 2-inch scale).
Muttra and Agra Districts . .	20 sheets on 4-inch scale.
Hutted camps in neighbourhood of Murree	5 sheets on 12-inch scale.
Cadastral maps of districts in North-West Provinces	4,090 sheets on 16-inch scale.
Cadastral maps of districts in British Burma	962 sheets on 16-inch scale.

The following maps drawn in the Revenue Survey Office have also been published, *viz.*:—

Bannu and Dera Ismail Khan Districts .	16 sheets on 1-inch scale (drawn in 64 sections on 2-inch scale).
Midnapur District	3 sheets on 1-inch scale (drawn in 12 sections on 2-inch scale).

Besides the examination and drawing of maps, the time of the draftsmen has been largely occupied, as will be seen from table B, in attending to calls for miscellaneous maps and records.

224. All the records received have been examined and brought on the register of the office, the usual final check on the computations having been carried out in the case of the records of three of the parties. The new register of maps and other records has been completed. A large section of the office establishment is still regularly employed on matters connected with bills and accounts.

225. The Deputy Surveyor-General acknowledges the very valuable assistance he has received from Major F. Coddington in all matters connected with the administration of the Revenue Branch. During Major Coddington's absence on privilege leave, his place was filled for two short periods by Majors H. S. Hutchinson and W. H. Wilkins successively.*

* Mr. F. W. Kelly, Surveyor, 1st grade, as head of the drawing section of the office, has, as always, rendered most willing and excellent service. Mr. W. Sinclair, Surveyor, 2nd grade, in charge of the cadastral map examination, has given entire satisfaction. Messrs. T. W. Reilly, J. Connor, and W. J. Lane, Surveyors and Draftsmen in their several capacities, have all done good and approved work.

Mr. A. E. Byrn, Mr. A. C. Cunningham, Mr. Gopal Chunder, Lahn, Baboos Harri Har Sen, Kally Pudo Banerjee, Doorga Narain Ghose, Bama Churn Chuckerbutty, and Jado Nath Mookerjee, together with the rest of the establishment, have all given satisfaction.

3.—LITHOGRAPHIC BRANCH.

226. The number of maps, plans, drawings, &c., printed during the year, amounts to 181,858 copies, or 21,511 more than last year; of these, 135,553, or about three-fourths, were printed for other departments, the remainder were for the requirements of this office.

Personnel.

Major R. V. Riddell, R.E., in charge.
Mr. H. L. Lepage, Officiating Head Assistant.
„ H. G. Ferns ... ... } Draftsmen.
Baboo Boloram Nath ... ... }
Munshi Mahomed Azim ... ... }
„ Sobhan Buksh, and 22 others. }
Mr. H. Niven, Chromo-Lithographic Printer, 1 Press Assistant, and 59 others.
Mr. E. D'Pyvah, Type Printer, and 22 others.
Three Native Clerks.

227. The map of Southern Afghanistan, in 4 sheets, has been issued during the year. The original compilation was drawn in outline at the Head-Quarters Office, then photographed, and carbon transfers supplied from the Photographic Branch. It had been decided to publish this map in two colours; one for the names, outline, &c., the other for the hills. The size of the sheets is large, and maps printed from carbon transfers are always considerably larger than the originals, but the increase in length and width is not uniformly proportional. In order that the size of the map, when published, should be as nearly as possible in accord with the scale on which it was drawn, it was decided to lay the transfers down in a way which had not hitherto been done in this office. The lines of latitude and longitude of each sheet were projected upon two stones—one for the outline, the other for the hills; the carbon transfers were then cut up into small pieces and attached to the stones in their proper places; they were then slightly damped by allowing wet blotting paper to remain over them for a few minutes, after which the stone was passed through the press in the usual manner; in this way the expansion of the transfer paper was reduced to a minimum and equally divided over the whole sheet; after adjustment of borders, &c., blue prints on drawing paper were supplied to the Drawing Branch, and on these the hills were drawn in black, then photographed, and the carbon transfers treated in the same manner as those of the outline map. This procedure has proved very satisfactory.

228. Another important work was undertaken during the year, *viz.*, a map of India in 6 sheets, on the scale of 1 inch=32 miles. The transfers of a greater portion of the outline and names were taken from the engraved maps, and additions and corrections were carried out on the stone direct. The hills were drawn on small sheets of transfer paper, and laid down on the stones in their proper positions, care being taken that the hill drawing was transferred to the stones not later than ten days after the first day's work on each sheet had been commenced.

229. The following district maps, *viz.*, Cachar, Hazaribagh, Mymensingh, Noacolly, and Backergunge, taken from the engraved plates of the Atlas of India have been published during the year. Five other maps have been transferred to stone, and will be published shortly, *viz.*, Beerbhoom, Sonthal Pergunnahs, Balaghat, Kamroop, and Raipur.*

4.—THE PHOTOGRAPHIC OFFICE.

230. During the year under review this office has been under the superintendence of Major Cowan, because of the absence of Major Waterhouse on furlough. The tabular statements in the appendix give a comparison of the amount and value of the work executed in this office during the present as compared with the previous year; also a summary of the work executed for other Departments; also an abstract of the cost of the office, with a balance sheet for the financial year 1880-81.

Personnel.

Major S. H. Cowan, B. S. C., Officiating Assistant Surveyor-General, in charge.

Negative Branch.

Mr. J. Mackenzie, Photographer
„ C. Marshall, ditto.
„ L. Lagnier, ditto.
„ G. G. Dempster, Asst. ditto.
„ T. Lloyd, „ ditto.
and 16 Assistants, retouchers, glass cleaners, &c.

Silver Printing Branch.

Umbica Charan Bhattacharjee, Assistant Photographer, and 1 native assistant.

Photographic Transfer Branch.

Mr. J. Harrold, Photographer, on furlough to Europe from 21st April 1881.
„ R. George, Photographer, and 6 native assistants.

Zinc Printing Branch.

Mr. B. Mackenzie, Zincographer.
„ J. Watson, ditto.
„ E. A. LeFranc, ditto.
13 zinc correctors, 12 printers, 9 grainers and 40 pressmen.

Office and Store Branch.

Mr. E. A. Caddy, Store-keeper.
Baboo Kanayi Lall Sen, Head Clerk, and 4 native clerks.

* The Head Assistant, Mr. Jevezy, who had obtained furlough to Europe for one year, from June 1879, resigned his appointment on the expiration of his leave. Mr. Lepage has continued to officiate for Mr. Jevezy and has conducted the duties of the office very satisfactorily. Mr. Niven has supervised the printing with his usual skill and assiduity. The following Native draftsmen deserve special notice,—Boloram Nath, Mahomed Azim, and Umbica Churn Mookerjee.

231. The following table gives a general abstract of the work performed during the present year:—

	Original sections or sheets.	Negative plates.	Photozincographic transfer prints.	No. of plates.	No. of pulls.	Number of printed sheets of each subject.		Silver and other prints.
						Single.	Combined.	
Topographical maps	60	191	161	52	6,130	6,200	6,200	116
Revenue Survey maps	308	347	357	58	14,940	17,820	17,370	12
General maps	3	...	...	11	1,650	600	600	...
City and Cantonment plans	20	56	56	26	1,965	1,975	975	...
Miscellaneous, Departmental	167	347	382	265	12,204	28,326	25,050	137
,, Extra Departmental	403	337	317	395	45,840	170,155	159,249	293
Transfers and proofs	...	...	...	...	1,817	...	...	...
Total	961	1,278	1,273	807	84,546	225,076	209,144	558
Cadastral, North-Western Provinces.								
Photozincographs	2,476	2,476	2,667	2,803	70,334	70,334	48,820	...
Zincographs	824	...	...	824	20,600	20,600	20,500	...
Re-transfers	...	...	...	73	1,825	1,825	1,825	...
Total	3,300	2,476	2,667	3,700	92,759	92,759	71,145	...
Cadastral, British Burmah.								
Photozincographs	1,100	1,100	1,085	878	29,853	29,853	9,423	...
Zincographs	108	...	...	108	3,672	3,672	1,394	...
Total	1,208	1,100	1,085	986	33,525	33,525	10,817	...
Cadastral, Bengal.								
Photozincographs	...	...	10	19	1,140	1,140	1,140	...
Transfers and proofs for cadastral maps	...	...	...	...	9,483	...	...	...
GRAND TOTAL	5,469	4,854	5,035	5,512	221,453	352,500	292,546	558

232. There has been a considerable diminution in the out-turn of geographical and military maps, owing to the withdrawal of the British troops from Afghanistan. On the other hand, there has been a still greater increase in the out-turn of cadastral maps, of which no less than 4,545 have been issued, 30 copies of each on an average being printed. The value of the out-turn is estimated at Rs. 22,000 for the topographical maps of this Department, Rs. 17,000 for maps and plans executed for other Departments, and Rs. 66,000 for cadastral maps.

233. The reduction in the cost of the collodion now prepared in this office, as compared with the cost at which it was purchased in 1876, is estimated to cause a saving of at least Rs. 4,000 annually.*

* Major Cowan reports favourably of the work of all his European assistants, and specially commends Messrs. J. and B Mackenzie, and Messrs. Watson, Marshall, and George.

234. Major Waterhouse received an extension of furlough for 9 months. Though on leave, he has, as on previous occasions, devoted a great part of his time to visiting various establishments on the Continent with the object of acquiring information on processes likely to be of use in the Department, and spent some months in working out practically in England, the details of a heliogravure process similar to that used at the Military Geographical Institute at Vienna. As the reports submitted by Major Waterhouse from time to time to the Secretary of State have not all been received, they will be noticed in the Annual Report for next year, when it is hoped that some of the processes studied by Major Waterhouse will have been successfully introduced into the working of the office.

5.—THE MATHEMATICAL INSTRUMENT DEPARTMENT.

235. During the year 1880-81, the stock of instruments in the depôt was increased as follows, *viz.*, about 7,540 instruments, amounting in value to Rs. 1,14,440, were obtained from England; 500 were purchased locally at a cost of Rs. 3,450; nearly 9,950 were manufactured in the workshop at a cost of a little over Rs. 12,500; nearly 5,970 instruments, in value a little more than Rs. 63,700, were received by inter-departmental exchange, of which about 1,640 were serviceable and 4,330 were repairable; and about 4,050 instruments, forming part of the repairable stock, were repaired on the premises and rendered fit for future issue at a cost of about Rs. 12,100, which after repair were valued at nearly Rs. 34,100.

Personnel.

Major R. V. Riddell, R.E., Superintendent.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument-maker.
Mr. B. J. Cardozo, Officiating Assistant Mathematical Instrument-maker, from 1st April 1880 to 24th February 1881.
Mr. F. Marshall, Assistant Mathematical Instrument-maker, from 25th February 1881.
64 Permanent Artificers.
63 Temporary Artificers (on an average).

Store Branch.

Mr. G. R. Alderman, Store-keeper.
Baboo Womesh Chunder Chowdry, Material Store-keeper.
1 Packing Sircar.
2 Packers.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ J. W. Collins, 2nd Clerk.
6 other permanent Clerks.
1 Extra Clerk.

236. The number of instruments issued from the stock amounted to 20,158, of which the value exceeded Rs. 1,15,600. These were distributed as follows:—

	Approximate.	
	Number.	Value.
		Rs.
To the Survey Department	8,830	45,720
„ Marine „	160	2,460
„ Military „	580	7,050
„ Public Works Department	3,410	37,000
„ Educational „	90	1,330
„ Miscellaneous „	6,080	17,260
„ Road Cess Committees, District Engineers, &c., entitled to receive instruments on payment when they can be spared	580	3,590
„ Workshop to complete repairs of instruments .	410	1,210
	20,140	1,15,620

About 1,550 instruments were repaired for various departments at a cost of a little less than Rs. 10,300.

237. The number of instruments locally purchased was considerably lower than during the previous year; still about 500 were necessary, in which number over 250 measuring tapes and 90 rules and scales of sorts were included. The remainder comprised small quantities of miscellaneous instruments. These were procured at an average cost of about 10 per cent. in excess of the value at which similar instruments procured from England would have been

issued. Formerly, the great mass of instruments were issued at too low a rate (25 to 35 per cent. lower than the market rate), and in consequence attempts were often made to purchase instruments from this department by many who ought to have applied to the Trade. Now, the rating of the stock having been increased as stated in paragraph 256 of last year's report, available instruments are sold at a rate of 10 per cent. in excess of the rates for issue on the public service, or at about the same price at which they can be procured from some of the Calcutta firms.

238. The following list enumerates the articles which form the bulk of the manufactures in the workshop:—

Names of Articles.	No.	Cost of manufacture.
		Rs.
Boards, drawing	15	160
Clinometers, rough	200	300
Compasses, magnetic, for plane-tables	114	1,362
Glasses, tracing	5	443
Idiometers	2	1,200
Machines, map printing, ordnance pattern	6	330
Pins for measuring chains	2,500	250
Plane-tables	50	500
Pluviometers	60	964
Rules, sight, for plane-tables	305	1,689
Squares, optical	100	650
Stands for various instruments	114	927
Stamps for conventional signs	72	260
Packing cases	536	1,635

239. The total number of instruments repaired in the workshop was a little over 5,600, and the cost of the repairs was very nearly Rs. 22,400. The principal instruments repaired were as follows:—

	Number repaired.		Number repaired.
Anemometers	15	Rules, flat and parallel	236
Barometers	46	„ sight for plane-tables	119
Chains	608	Scales	83
Compasses, prismatic	141	Sextants	16
„ surveying	165	Squares, optical	129
Drawing instruments, miscellaneous	1,020	Stands for various instruments	456
„ „ cases of 1st, 2nd, & 3rd classes	124	Staves, leveling	91
Levels, dumpy γ	95	Tapes	46
Machines for map printing	32	T. squares	84
Plane-tables	167	Theodolites	68

240. The out-turn of the workshop, as represented by the combined value of manufactures and repairs, was somewhat less than in the year 1879-80. This result is attributed to the fact that during the year under report the Instrument-maker, Mr. T. Bolton, was absent on privilege leave for three months, during which period a substitute, possessing very inferior qualifications for the post, was employed, who, however, was the best available. The work of the Store Branch was considerably greater than in the year 1879-80, which is chiefly accounted for by the circumstances stated in paragraph 254 of last year's report, *viz.*, that the greater proportion of the Cores due in 1879-80 did not arrive till 1880-81, so that whereas in the former year only 250 instruments, valued at Rs. 8,200, were received from England, in the latter year nearly 7,550 instruments, valued at nearly Rs. 1,14,500, arrived from that source. The issue of instruments, &c., were also more numerous than in the previous year, and, with the exception of the year 1878-79, were larger than in any of the past five years.

241. During the year under report endeavours were made to utilise the resources of the town in the manufacture of some of the simpler class of instruments, in order that the services of the comparatively skilled artisans of the Instrument Department might be made available for the repair of the higher class of instruments, of which there is always a large number in store, and which requires the best workmanship with close supervision; nearly 300 pairs of brass sights for plane-table sight rules, and over 60 brass cases for magnetic compasses, and 450 sets of iron numbers for measuring chains, were made in this manner, chiefly by Native contractors, at a cost of Rs. 845. These component parts were

then combined with others made in the department with a perfectly satisfac tory result. During the current year, the system is being still farther extended, but Major Riddell considers that it should be worked cautiously, so as not to offer too great an inducement to the class of workmen employed on similar jobs, in the Government workshop, to forsake Government service in the hope of attaining a more lucrative business; should the trained workmen leave too rapidly, the result would be most unsatisfactory, for such workmen cannot be trained in less than from 7 to 10 years.

242. The profit and loss account of the workshop showed a loss of a little over Rs. 1,800, the charges having amounted to Rs. 40,469, whereas the value of work done was estimated at Rs. 38,641. This result is due not to an increase in the charges, but to a decrease in the out-turn of the workshop, and is attributed by the Superintendent to the absence, during a quarter of the year, of the Instrument-maker, who has the direct management of the workshop. The cost of the remaining portion of the establishment, including supervision, office accommodation, packing expenses, &c., was about Rs. 13,000, which may be considered to have been expended on the receipt and issue of more than 44,000 instruments, valued at about Rs. 3,09,800.*

6.—The Trigonometrical Survey Office.

243. The principal work of this office is the final reduction and publication of the triangulation of all parts of India, and the reproduction of the topographical surveys executed in the Trigonometrical Branch of the Department. The office being located at Dehra Dun, at a considerable distance from Calcutta, has a drawing, a photozincographic, and a printing branch of its own; it is thus independent of all extraneous assistance in the matter of publication, excepting as regards the binding of its printed matter, which has to be done elsewhere, usually at Calcutta. The office has also a depôt of instruments and stores attached to it, chiefly containing the higher class of instruments appertaining to the Great Trigonometrical Survey, of which it has long been the Head-Quarters Office. It is now, and has for many years been, under the immediate and able superintendence of Mr. Hennessey, M.A., F.R.S., aided by Mr. Cole, M.A.

Personnel.

J. B. N. Hennessey, Esq., M.A., F.R.S., Deputy Superintendent, 1st grade, in charge.
W. H. Cole, Esq. M.A., Assistant Superintendent, 1st grade.

Computing Branch.

Mr. C. Wood, Surveyor, 2nd grade.
„ H. W. Peychers, Surveyor, 4th grade.
Baboo Gunga Purshad, Computer.
„ Cally Mohun Ghose, Computer.
„ Kally Coomar Chatterjee, Computer and 10 other Computers, &c.

Printing Branch.

Mr. M. J. O'Connor, Printer, from 1st to 31st October 1880.
Mr. B. V. Hughes, Printer, from 1st November 1880.
15 Compositors and Apprentices.

Correspondence and Stores.

Mr. H. E. T. Keelan, Surveyor, 2nd grade, 2 Native Writers.

Solar Photography.

Mr. L. H. Clarke, Surveyor, 2nd grade.

Photozincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
1 Native Apprentice Photographer.
2 Native Draftsmen.
1 Native Assistant Draftsman.
1 Map Keeper.

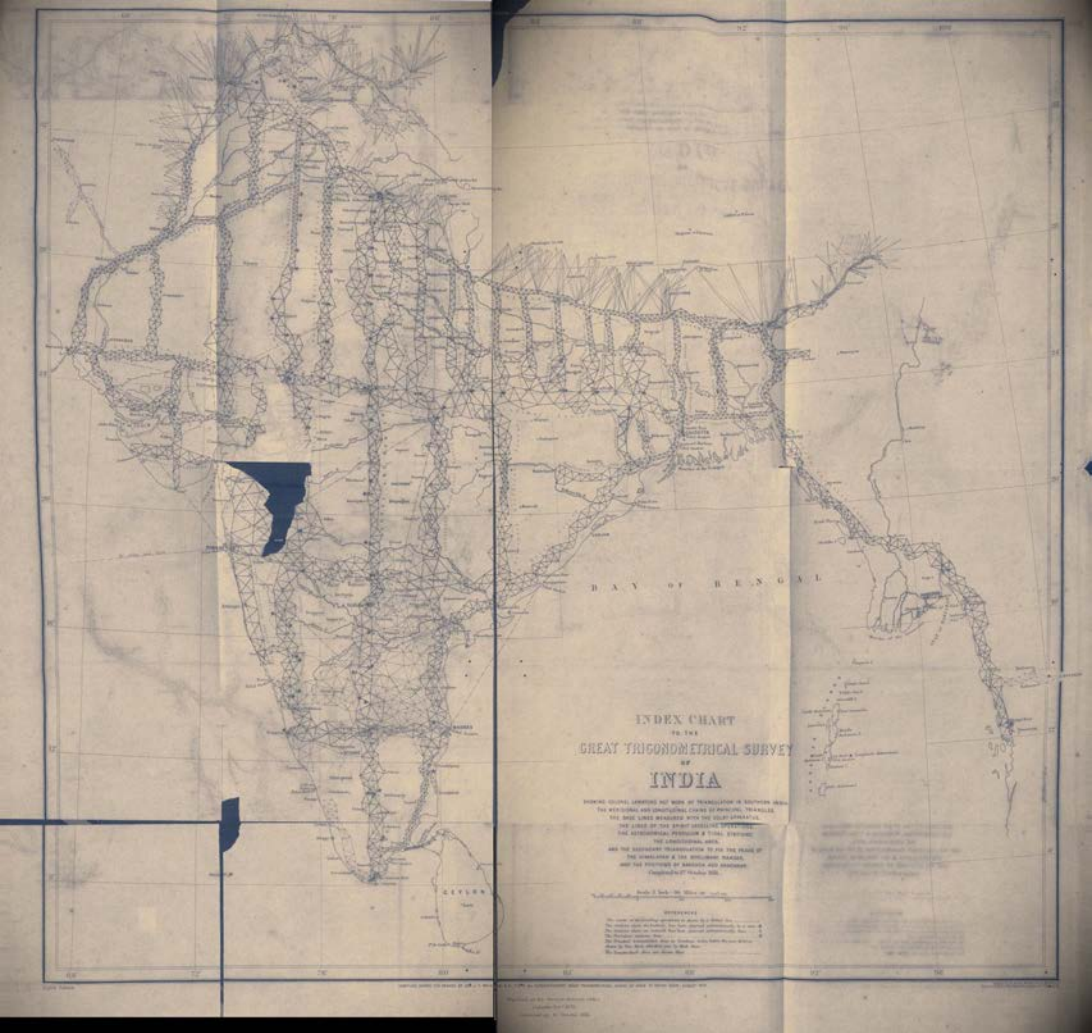
Drawing Branch.

Mr. G. W. E. Atkinson, Surveyor, 2nd grade.
Mr. H. G. Ferns, Draftsman.
Jafer Khan, and 6 other Draftsmen.
14 Assistant Draftsmen and Map Colorists.

244. The great work of the final reduction of the observations and measurements, both linear and angular, of the Great Trigonometrical Survey, and the publication of the results, has been making good progress.

245. The more important calculations accomplished during the year were performed in connection with the final reduction of the principal triangulation comprised (1st) in the figure known departmentally as the southern trigon, which comprehends the whole of the triangulation of India below the parallel of 18½°; (2ndly), in the Eastern Sind Series; and (3rdly), in the Eastern Frontier (Burma) Series. Various secondary triangulations, which rest on the previously reduced sections of the principal triangulation known as the North-East and the South-East Quadrilaterals, were finally adjusted. The final reduction of the astronomical observations for determinations of latitude was continued, as described in paragraph 259 of last year's report.

* Major Riddell reports favourably on the work of Mr. Bolton, the *Mathematical Instrument-maker*, and of Mr. F. Marshall, a trained Instrument-maker, who arrived from England in the month of February 1881 to fill the post of Assistant Mathematical Instrument-maker.


BAY OF BENGAL
CEYLON
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

246. The completion of volumes VII and VIII of the Account of the Principal Triangulation has been found to be a more laborious matter than had been anticipated. Those volumes are devoted to the several chains of triangles comprised in the North-East Quadrilateral which, speaking broadly, covers the area included from north to south between the Himalayan Mountains and the parallel of Calcutta, and from west to east between the Central Indian meridian 78°, and the Eastern Frontier meridian 92°. The preparation of the introductory narrative accounts of the field operations in each of the several chains of triangles, and of the chapters explanatory of the simultaneous reduction of the triangulation, has been carried on as uninterruptedly as was possible, and upwards of 400 pages quarto have been passed through the press during the present year; but the volumes will not be completed and ready for publication much before the end of next year. Considerable progress has been made with volume X on the Electro-Telegraphic longitudes, of which 480 pages were printed.

247. Volume VI, which treats of the South-East Quadrilateral, and of which the printing was completed during the previous year, has this year been bound and distributed to the principal scientific libraries and geodesists in all quarters of the globe.

248. Of the Synoptical Volumes which give a precis of the results of the whole of the triangulation, both principal and secondary, for the requirements of topographers and geographers, volumes X to XIII have been printed and bound, and are now ready for distribution, and volumes VIII and IX have been distributed.

249. The Auxiliary Tables for facilitating the calculations of the Indian surveys, have been supplemented by a valuable paper and series of tables by Mr. Cole for the calculation of the distance and mutual azimuths of any two points, whose latitudes and longitudes are known.

250. Pamphlet No. 3 of heights in the Bombay Presidency derived from the Spirit-Leveling operations, has been printed. The anomalies presented by the leveling operations in Southern India were carefully enquired into, as already described in paragraphs 194 to 200 of this report. Further publication has been suspended pending the result of these enquiries.

251. The fifth edition of the map of "Turkestan, and the countries between the British and the Russian dominions in Assia," was completed. It includes all the geographical information received up to date from the survey officers employed with the army during the recent campaigns in Afghanistan, and all the latest information procurable from the Topographical Branch of the Russian War Office and other quarters. A new map of the country around Gilgit was compiled from the recent survey of Lieutenant-Colonel H. C. B. Tanner. The Route Map of the Western Himalayas, originally prepared by the late Colonel T. G. Montgomerie, was revised and added to with a view to the publication of a new edition which is being engraved on copper-plate.

252. Two sheets, Nos. 75 and 82, of the Charts of Spirit Levels have been completed and published, and four more sheets have been nearly completed. Pending publication a large amount of level data was supplied in manuscript to meet the immediate requirements of officers making surveys for the Sardah Canal.

253. The "Index Chart to the Great Trigonometrical Survey," an engraved copy of which faces the present section, has been added to and brought up to date. The most interesting recent additions, apart from the principal triangulation, are the longitudinal arcs, the tidal stations, and the chains of secondary triangles eastwards to Bangkok and westwards to Kandahar.

254. All the maps of the current year's work of the Guzerat and Kattiwar-Cutch topographical parties, and those of the Forest Survey Department, have been examined and published, and a large amount of miscellaneous work has been executed as specified in detail in the appendix. The amount realised from the sale of maps during the year was Rs. 1,052.

255. The solar photographs, for the Solar Physics Committee, South Kensington, have been taken every day of the year when the sun was visible. On 295 days solar phenomena were visible, on 12 days no phenomena were visible, on 55 days the sun was hidden by clouds and could not be photographed, and on 3 days the observations were failures. The percentage of days on which the

sun being visible spots were observed on its surface, has increased from 30 in 1877-78, and 28 in 1878-79, to 96 in 1880-81. A sunshine recorder has recently been established in connection with the solar photography. Actinometric observations have been taken occasionally as opportunity permitted.

256. A set of ordinary mercurial thermometers has been adapted for employment as earth thermometers, and inserted in the ground at depths of 1·1, 3·2, 6·4, 12·8, and 25·6 feet below the surface: the maximum temperatures were found to occur at 6·4 feet on the 20th September, at 12·8 feet on the 15th October, and at the lowest depth on the 15th November.

257. His Excellency the Viceroy and Governor-General honoured the office with a visit on the 6th November 1880.*

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* Mr. Hennessey acknowledges the valuable assistance he has received from Mr. Cole in general co-operation and supervision.

He also reports very favourably of the services rendered by Mr. Wood and Baboos Gunga Persad and Cally Mohan Ghose in the Computing Office, and commends Messrs. Keelan, Atkinson, Peychers, Ollenbach, Hughes, and Dyson.

Southern Section. Fourth Edition.

INDEX TO LEVEL BOOKS IN THE G. T. SURVEY, PUBLISHED AND UNDER COMPILATION.

Sheet No. 1.

Summary of Out-turn of Work executed by the TRIGONOMETRICAL PARTIES during the Survey Year 1880-81.

Description of details.	Eastern Sind Series, 24-inch theodolite.	Eastern Frontier Series, 24-inch theodolite.	Spirit Leveling Operations.	Remarks.
Number of principal stations newly fixed . . .	13	6	...	
„ „ „ triangles completed . . .	19	7	...	
Length of principal series in miles	50	70	...	
Area of principal triangulation in square miles . .	733	455	...	
Average triangular error in seconds	0·22	0·23	...	
Average probable error of angles in seconds ± . .	0·21	0·29	...	
Astronomical azimuths of verification	2	...	...	
Number of principal stations selected in advance . .	...	16	...	
Number of towers, pillars, and platforms constructed for principal stations	6	12	...	
Number of principal stations placed under official protection	15	2	...	
Number of principal stations the elements of which have been computed	29	2	...	
Number of secondary triangles of which all three angles have been observed	33	7	...	
Lengths of secondary series in miles	154	30	...	
Area of secondary triangulation in square miles . .	1,564	323	...	
Ditto embraced by triangulation to prominent points exterior to principal triangulation and in square miles.	...	8,000	...	
Number of points fixed by intersection, but not visited .	19	...	...	
Number of Revenue Survey stations and boundary pillars	8	...	...	
Number of stations and points, the heights of which have been determined	48	2	...	
Number of miles of rays cleared	175	31	...	
„ „ preliminary charts of triangulation . .	2	1	...	
„ „ hill tops cleared of forest or jungle . .	...	21	...	
„ „ miles levelled over	...	...	376	
„ „ permanent bench-mark stones embedded .	...	...	26	
Number of trigonometrical stations connected with lines of levels	...	...	7	
Number of other permanent points fixed as bench-marks	...	...	295	

Summary of Out-turn of the work of the TOPOGRAPHICAL

Scale of Survey.	Topographical Survey.	TRIANGULATION. Instrument used.	Area triangulated in square miles.	Number of stations at which observations were taken for latitude.	Number of square miles to each point fixed trigonometrically.	Number of square miles to each height.	1st class triangulation, in which each angle is usually observed on four zeros, or more. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	2nd class triangulation, in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	3rd class or tertiary triangulation, in which two angles only of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined by barometrical observations or otherwise.
1 inch = 1 mile.	No. 7 Topographical Party, Rajputana.	12" Theodolite.	4,500	49	...	...	...	...	...	...	...	31	43	4"·8	0·29	43	375	699	0·52	233	21
1 inch = 1 mile.	No. 5 Topographical Party, Bhopal and Malwa.	10" „	273	12	5·8	6·4	...	...	...	...	...	8	27	1"·1	0·35	10	47	122	0·77	43	134
1 inch = 1 mile.	No. 8 Topographical Party, Mysore.	8" „	820	10	13·9	20	...	...	...	...	...	59	20	3"·1	0·32	10	49	88	1·01	31	524
2 inches = 1 mile.	No. 2 Topographical Party, Khandesh and Bombay Native States.	10" and 6"	1,699	97	2·9	3·2	3	8	6"·5	0·17	3	37	250	10"·3	0·33	56	379	706	1·15	249	323
2 inches = 1 mile.	Guzerat Party . . .	10", 8" and 7", „	1,543	132	2·1	4·3	..	...	...	...	...	99	169	11"·8	0·28	98	730	1,131	0·59	311	220
2 inches = 1 mile.	Kattywar Party . . .	7"	1,360	68	2·9	5·1	...	...	...	...	...	68	114	9"·0	0·5	62	400	648	1·3	200	170
6 inches = 1 mile.	Bhopal and Malwa (No. 5 Topographical Party).	12" „	...	10	...	...	...	...	...	...	...	8	14	10"·9	2·25	...	96	171	2·74	26	...
8 inches = 1 mile.	Gwalior (No. 1 Topographical Party).	12" and 7". „	...	4	...	...	...	...	...	...	...	3	9	5"·2	0·13	3	37	58	0·79	54	71
4 inches = 1 mile.	Rajputana (No. 7 Topographical Party).	5" omnimeter.	13·95	46	3·8	0·2	...	...	...	...	...	35	93	2·7"	4·3	35	296	586	5·9	497	48

PARTIES between 1st October 1880 and 30th September 1881.

Scale of Survey.	Topographical Survey.	Traverse. Instruments used.	Traverse. Number of Stations at which the Theodolite was set up.	Traverse. Linear miles, simple traversing.	Traverse. Linear miles, Boundary Survey.	Traverse. Average angular error per station in seconds.	Traverse. Average error per 1,000 links in links.	Traverse. Number of village triangulations fixed.	Traverse. Number of plane-table points fixed.	Topography. Final Topography completed during the season, in square miles.	Topography. Average number of plane-table fixings per square mile.	Topography. Number of linear miles of test line by which each man's work has been tested.	Names of districts, &c., through which the season's operations have been carried.	Area of triangulation in advance of Topography.
														Sq. miles.
1 inch = 1 mile.	No. 6 Topographical Party, Khasi and Garo Hills.	...	...	...		...	...	...	...	192·7	0·15	Examined *in situ*.	Sylhet and Hill Tipperah .	1200
1 inch = 1 mile.	Kattywar Party	...	...	...	...	...	...	...	...	813	...	...	Cutch.	...
1 inch = 1 mile.	No. 7 Topographical Party, Rajputana Survey.	...	...	...		...	...	...	...	5010·0	1·7	Examined *in situ*.	Bickaneer and Jodhpore .	7200·0
										6015·7				
1 inch = 1 mile.	No. 1 Topographical Party, Gwalior and Central India.	...	...	...	...	. .	...	...	...	1217·5	13·0	...	States of Oodeypore, Sirohi, Jodhpore, and Danta.	3925·0
1 inch = 1 mile.	No. 5 Topographical Party, Bhopal and Malwa.	...	...	...	...	...	...	...	...	1556·2	7·0	61·5 Examined *in situ*.	Indore, Gwalior, Rutlam, Jaora, Sailana, Jhabua, Kusalgarh and Sitamau.	1638·0
1 inch = 1 mile.	No. 8 Topographical Party, Mysore.	. .	...	...	...	...	..	...	...	3438·0	10·6	Examined *in situ*.	Districts Shimoga, Kadur, Chitaldroog, Tumkur, and Hassan.	1428·0
1 inch = 1 mile.	Kohat Party	...	...	...	...	...	...	...	...	398·0				
										6609·7				
1 mile.	No. 2 Topographical Party, Khandesh and Bombay Native States.	5" Theodolite.	1,095	510·0	...	0"·09	0·6	483	...	1493·0	19·3	264·9	Talukas of Bhusawal, Erandole, Jamner, Nasirabad, Pachora and Dhulia. Nizam's Territory and Berar boundaries.	2900·0
1 mile.	No. 6 Topographical Party, Khasi and Garo Hills.	5" Theodolite and compass.	...	..	36·9	...	...	...	...	151·5	3·1	Examined *in situ*.	Sylhet and Hill Tipperah.	
			...	571·3	...	...	...	..	...					
2 inches = 1 mile.	Guzerat Party	6" and 5½"	4,151	795·3	192·2	13"·9	1·7	...	331	1584·9	23·9	643	Surat, Ahmedabad, and Khandesh Collectorates, and States of Baroda, Mahi-Kanta, Rewa-Kanta, and Radhanpur.	3,389
2 inches = 1 mile.	Kattywar Party	5" Theodolite.	1,333	125	74	16"·1	2·1	...	...	1658	11·0	370	Cutch	1,764
										4687·2				
4 inches = 1 mile.	Guzerat Party	...	...	...	...	.	...	...	...	75·5	65·3	24·9	Dang Forest	170·0
6 inches = 1 mile.	Bhopal and Malwa (No. 5 Topographical Party).	6" Theodolite.	37	19·7	...	0"·7	1·21	...	165	18·90	...	4·89	Ujjain City.	
		...	...	...	...	...	...	...	...	7·10	...	3·47 Examined *in situ*.	Rutlam City.	
		...	...	.	...	...	...	...	...	7·10	521·1	Examined *in situ*.	Jhabua City.	
8 inches = 1 mile.	Rajputana (No. 7 Topographical Party).	...	...	..	...	...	...	...	...	10·80	531·8	...	Kasauli extension and Cholera Camp (60120 acres).	
1 mile.	Khandesh and Bombay Native States (No. 2 Topographical Party).	..	...	...	.	...	...	...	...	10·50	...	..	Dhulia City and Cantonment.	
8 inches = 1 mile.	Gwalior (No. 1 Topographical Party).	...	...	...	.	...	...	...	...	3·03	...	...	Kotra Cantonment.	
2 inches = 1 mile.	Rajputana (No. 7 Topographical Party).	...	.	...	...	...	..	...	...	1·764	1415·0	Examined *in situ*.	Dagshai Cantonment (1128·90 acres).	
		...	...	...	...	...	...	...	..	0·689	85·40		Solon Cantonment (440·83 acres).	
		...	...	..	.	...	...	...	...	0·70	1706·0		Jutogh Cantonment (445·00 acres).	

Summary of the Out-turn of the field work of the REVENUE BRANCH

Designation of Survey Party.	Scale of Survey.	Where employed. Province.	Where employed. District.	No. of Villages.	Area completed. Topography and Detail.	Area completed. Traverse. In advance.	Area completed. Triangulation. In advance.
					CADASTRAL SURVEYS.		
					Sq. miles.	Sq. miles.	Sq. miles.
No. 4 Party.	16 inches — 1 mile	North-West Provinces	Ghazipur	1,389	526 (a)	207	...
	Ditto	Ditto ditto	Ballia	86	79 (c)	208	...
„ 5 „	Ditto	Ditto ditto	Mirzapur	978	637	540	...
	Ditto	Ditto ditto	Tarai	20	28	...	...
„ 6 „	Ditto	Ditto ditto	Jaunpur	1,043	472 (e)	...	...
„ 2 „	Ditto	British Burma	Hanthawaddy	482	787	258	...
				River	61	...	...
„ 7 „	Ditto	Ditto	Tharrawaddy	153	461	205	...
„ 8 „	Ditto	Ditto	Bassein	193	562	508	...
			TOTAL OF CADASTRAL SURVEYS	4,344	3,613	1,926	...
„ 1 „	12 inches — 1 mile	Punjab (h)	Hazara and Rawalpindi	...	3·7	...	...
					MAUZAWAR SURVEYS.		
„ 1 „	4 inches = 1 mile	Punjab	Dera Ismail Khan	54	1,943	...	...
	Ditto	Ditto	Rawalpindi	...	371	...	...
„ 3 „	Ditto	North-West Provinces	Meerut (adjoining River Jumna).	...	150	...	...
			TOTAL OF MAUZAWAR SURVEYS	54	2,464	...	...
					TOPOGRAPHICAL SURVEYS.		
„ 2 „	2 inches = 1 mile	British Burma	Hanthawaddy	...	60	...	...
„ 3 „	Ditto	North-West Provinces	Meerut	...	1,539	...	...
	Ditto	Ditto ditto	Bulandshahr	...	...	973	...
„ 10 „	Ditto	Bombay	Thana and Colaba	...	1,610	700	400
„ 11 „	Ditto	Ditto	Sholapur, Satara, Kaladgi, and Nizam's Dominions.	...	2,036	820	964
			TOTAL OF TOPOGRAPHICAL SURVEYS	...	5,245	2,493	1,364
			GRAND TOTAL	...	11,326	4,419	1,364

ABSTRACT ACCORDING TO JURISDICTIONS.

Province.	Scale of Survey.	Area surveyed in square miles.	Cost.	Average rate per square mile.	Remarks.
			Rs. A. P.	Rs. A. P.	
North-West Provinces	2-in. = 1 mile	1,539	48,708 14 8	31 10 5	
	4-in. = 1 mile	150	7,755 14 0	51 11 3	
	16 in. = 1 mile	1,742	2,77,518 4 9	159 4 11	
Punjab	4-in. = 1 mile	2,314	59,456 7 7	25 11 1	
	12-in. = 1 mile	4	2,959 0 0	.....	
Bombay	2-in. = 1 mile	3,646	1,05,662 8 3	28 15 8	
British Burma	2-in. = 1 mile	60	3,900 0 0	65 0 0	
	16-in. = 1 mile	1,871	4,68,750 14 5	250 8 7	
TOTAL	.....	11,326	9,74,711 15 8	.....	

DEPUTY SURVEYOR-GENERAL'S OFFICE,
Calcutta, 1st October 1881.

PARTIES between 1st October 1880 and 30th September 1881.

Designation of Survey Party.	Cost.	Rate.	No. of Fields.	Average size of Fields.	Remarks.
		Per Acre.			
	Rs. A. P.	Rs. A. P.		Acre.	
No. 4 Party	98,844 13 7 (*b*)	0 4 1	918,740	0 42	(*a*) This area is exclusive of 4 square miles of river appertaining to district Benares, surveyed, on 16-inch and of 42·57 square miles of overlap survey in districts Benares and Azamgarh on 2-inch scale.
	...	...	...	...	
„ 5 „	87,756 13 4 (*d*)	0 3 5	599,101	0·66	(*b*) Cost is exclusive of Rs. 2,627-3-3 expended on theodolite markstones, and of Rs. 1,116-13 expended on 2-inch survey.
	4,664 15 10	0 4 2	14,591	1·23	
„ 6 „	86,251 10 0 (*f*)	0 4 7	881,912	0·34	(*c*) Area is exclusive of 14·47 square miles of river appertaining to district Sarun, surveyed on 16-inch scale.
„ 2 „	1,70,860 8 0	0 5 0	359,820	1·40	(*d*) Exclusive of Rs. 3,700 expended on theodolite markstones, of Rs. 9,198-10-5 expended on Banda mapping, and of Rs. 1,225, furlough allowances of an European Assistant.
	...	...	...	...	
„ 7 „	1,11,051 9 4	0 6 0	299,673	0·43 (*g*)	(*e*) Inclusive of four villages of Oudh, area 0·72 square mile.
„ 8 „	1,86,838 13 1	0 8 4	259,096	0·58 (*g*)	(*f*) Inclusive of Rs. 3,694-6-6 during October 1881, and exclusive of Rs. 49-5-6 expended on station marks.
	7,46,269 3 2				(*g*) The average size of fields is on the cultivated portion only.
„ 1 „	2,959 0 0				(*h*) Special survey of military camps.
		Per sq. mile.			
„ 1 „	28,327 7 7	14 9 3			
	31,129 0 0	83 14 6			
„ 3 „	7,755 14 0	51 11 3			
	67,212 5 7				
„ 2 „	3,900 0 0	65 0 0			
„ 3 „	48,708 14 8	31 10 5			
„ 10 „	54,043 9 2	33 9 1			
„ 11 „	51,618 15 1	25 5 8			
	1,58,271 6 11				
	9,74,711 15 8				

DISTRICT COMPLETED SINCE LAST REPORT.

District.	Number of Villages.	Number of Fields.	Area in square miles.	Cost inclusive of all expenditure.	Final rate per square mile.	Nature of survey, by whom and when surveyed.	Remarks.
				Rs.	Rs. A. P.		
Jaunpur	3,498	2,861,279	1,551 (*i*)	3,24,917 (*j*)	209 7 10	Surveyed cadastrally on the 16-inch to the mile scale, by E. T. S. Johnson, Esq., Deputy Superintendent; commenced 1877-78, finished 1880-81.	(*i*) This area is inclusive of 26 outlying villages, area 11·45 square miles, situated within the province of Oudh, and is exclusive of 21 villages, area 14·43 square miles, of Oudh falling within the district.
N.-W. Provinces.		Average size of the field, 0·35 acre.			Per acre. 0 5 3		(*j*) Inclusive of expenditure of October 1881, and of a sum of Rs. 1,675-13-3 for station marks.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from a letter, dated 24th October 1881, from COLONEL C. T. HAIG, R. E., *on the Venice Geographical Exhibition and Congress.*

On arrival in England, I found that General Sir Henry Thuillier had been invited to go to Venice, as Lord Hartington had resolved on sending a contribution of maps to the Exhibition; and it was shortly afterwards decided that we were both to act in concert in representing India at the Exhibition and Congress.

Accordingly, it was arranged that I should reach Venice during the first week of August, to receive and set up the exhibits from India and from the India Office; and that I should advise Sir Henry Thuillier in due time, when I thought it desirable that he should follow me.

Before leaving England, Captain Baird having arrived on privilege leave from India and represented to me that you were of opinion that it was desirable that he should be at Venice, to superintend the setting up and exhibiting of the tidal instruments, I represented the matter to Colonel Yule, who kindly laid it before the Secretary of State; and Captain Baird was eventually appointed as my colleague. This, however, was not settled till nearly the end of August, and Captain Baird only reached Venice on the 26th of that month.

I arrived in Venice on the 4th August, when I was surprised to find that the building intended for our section of the Exhibition was not ready for the reception of the exhibits. I also then learnt from the Vice-Consul that the Ordnance, Survey, and the Admiralty were sending contributions of maps, charts, and books, and that he had been furnished with a sum of £100 to meet the expenses of exhibiting them, and had been directed to apply to Sir Henry Thuillier and myself for professional advice and assistance in the matter of exhibiting them to the best advantage.

As but one room had been allotted for England and India, it was evident that the only way of complying with this requisition was to take over the whole of the English exhibits myself, and treat them and the Indian exhibits as one collection. This I did, and, when the time came for closing my accounts, I received from the Vice-Consul a contribution towards the expenses, which we both considered a fair proportion for the English Government to pay. This service, which I accepted as a matter of courtesy to the Vice-Consul, would, however, have fallen to me as a matter of duty, as Lord Granville added my name with Sir Henry Thuillier's to the list of British Commissioners.

With the exception of a few maps, all the exhibits pertaining to the Survey of India and the Marine Survey of India reached Venice before I did. The maps and geographies contributed by the Educational Department, and the Government papers on the cultivation of cinchona and on the transliteration of Indian proper names, arrived too late for exhibition, as they did not reach till the Congress was over.

The available space in the Royal Palace being found insufficient to afford accommodation for the entire Exhibition, England, Russia, and Sweden were accommodated in a separate building. This consisted of a temporary structure erected on the broad path between the Royal Palace gardens and the main canal, annexed to a permanent building at the end of the path. The permanent building was allotted to Sweden and the temporary annexe was divided between Russia and England,—Russia being in the centre and England furthest from Sweden. The only means of ingress to both Russia and Sweden was through the length of the English section, a rectangular room 64 feet by 21. Owing to this, it was impossible, up to within a very short time of the opening of the Exhibition, to keep our room free from dust and litter, which compelled me to defer the setting up of the instruments till the last. Captain Baird's nomination was therefore most opportune, for he relieved me of the care of setting up the tidal instruments.

The cases containing the Indian exhibits arrived in good order, and, with but one or two exceptions, their contents suffered no damage on the voyage. The exceptions that did occur, prove that the cases had been subjected to some very rough handling, and therefore great credit is due to those who packed the instruments. The principal instance of damage was the Gastrell hand printing-press, the iron casting of which was broken in two at the bend. The self-registering aneroid, though very carefully packed in a box protected with soft fenders, was so severely shaken that the back of the aneroid case was bulged in on one side, so that the spindle, instead of projecting through the centre of the perforation in the face, was forced against its edge. This was, however, soon remedied. The boiling-point thermometer was injured so as, I fear, to render it useless: a star will be noticed inside the tube, at the neck of the bulb,—a very peculiar injury, as it is wholly internal. I may here mention a casualty that happened during the Exhibition. A young lad inadvertently overthrew the magnetic dip circle, his foot catching one leg of the stand: the fall bent the arm, carrying one of the vertical verniers, so much, that I could not attempt to rectify it, but I have no doubt it can be easily repaired in the Mathematical Instrument Department at Calcutta.

The Exhibition building being within 17 feet of the edge of the main canal, I sent Captain Baird a section showing the relative positions of the building and the water, and

asked him to bring a couple of wheels to transfer the vertical motion of the float of the self-registering tide-gauge horizontally across the 17 feet. Passing through London, he called on Mr. Roberts and procured wheels and copper band which he had ready made for the purpose, and so we were able to set the tide-gauge in motion, registering the tide of Venice; and this instrument became one of the most attractive objects in the whole Exhibition, and drew much attention, not only to itself, but to the tidal diagrams and the Indian tidal and leveling work generally, and afforded Captain Baird an opportunity of setting forth the excellence of these operations and their superiority over all work of a similar nature undertaken in any other country.

It was therefore very fortunate that our section of the Exhibition could not be accommodated in the Royal Palace, where such a happy effect could not have been attained. It was fortunate also for other reasons. The floor being within a few inches of a well-trodden path, I was able to exhibit all the theodolites and levels to great advantage. I had the floor cut and a solid masonry pillar built in the ground for the great theodolite, affording it perfect insulation; and for each foot of the other instruments I cut a hole in the floor, about 4 inches square, and sunk a strong square peg in the ground, the head of which was about an inch below the flooring—affording them also good insulation, as well as protection against any slight concussion, for the feet were each inside a countersunk enclosure. In the Palace, insulation was of course impossible, and the instruments of other countries there exhibited were mostly put on the tables, and not on their proper stands.

From the 4th August to 1st September my time was fully occupied in preparing the room and setting up the objects. One of the India Office messengers was sent with me, to help me, and I found there was ample work for us both, in unpacking the cases, getting maps mounted, seeing to the manufacture of tables, having the maps hung against the walls, and finally setting up the instruments and arranging objects for view on the various tables.

There was provided, as you are aware, for each instrument, a printed label, giving its name and in most cases a short description of its use and services. These I had translated into both French and Italian, so that there were labels in three languages attached to each instrument, rendering it easy for any interested visitor to ascertain the name and object of each. I also took care to keep the exhibits of the three principal departments distinguishable from each other, by distributing labels "Survey of India," "Ordnance Survey," and "Admiralty," made of black enamel letters on stout white paper, wherever it was necessary. The labels were of several sizes, placed according to the sizes of the groups to which they referred.

I forward with this report a general catalogue of the whole Exhibition, in two parts, and a supplement published in Italian by the Organising Committee, and an English catalogue compiled by myself—that is to say, it contains the catalogue of which you sent me 350 copies, with a few slight modifications, and catalogues of the maps, books, &c., sent from the India Office, the Ordnance Survey, and the Admiralty. The Admiralty supplied 50 copies of their own catalogue, and I had 300 more printed in Venice. The Ordnance Survey merely sent a manuscript list of their exhibits, of which I had 350 copies printed. Of the 350 complete catalogues, I reserved 50, which have been packed in one of the cases returning to India; the other 300 were distributed freely among all who could be found to understand English and take an interest in the collection.

The Exhibition was formally opened on the 1st September, by Prince Téano, and by that date all preparations had been fully completed, and the English section presented both a general aspect and a detailed display which were, I believe, generally commended.

As will be perceived from the photographs which accompany this letter, I placed the instruments on their respective stands up the centre of the room; and the tables, carrying the portfolios of maps and the books, at the sides of the room. This gave great prominence to the instruments; and conspicuous above all, in the centre of the room, stood the great theodolite, the signal apparatus also holding a prominent position, as it was the first object that attracted the eye on entering the room. Conspicuous among the maps against the walls was the one composed of the Indian Atlas Sheets, occupying a space of about 28 feet by 10 feet. This was the largest map in the whole Exhibition. Some of the maps mounted in the India Office were also very conspicuous, by reason of their great size,—notably the Kalka and Simla Road Survey, the map of Simla and Jutog, and the Town and Island of Bombay.

Besides covering all the available wall space with maps, I attached frames 7 feet high to the backs of three of the tables, 6½ feet long, which I placed end on to the walls, and thus acquired considerable additional space for hanging maps, which I also completely covered with such maps as I thought would be of most popular interest, which I took out from the portfolios and got mounted on rollers.

Among the visitors to the Exhibition, were the King and Queen of Italy and the young Prince of Naples; Prince Thomas, Duke of Genoa, and the Duke D'Aosta; Ismail Pacha, ex-Khedive of Egypt; Mons. Ferdinand Lesseps, Professor Vambery, Doctor Nachtigal, Major Serpa-Pinto; Lieut. Massari, the companion of the late Matteucci; Captain Burton, Commander Cameron, and other distinguished explorers and savans, besides, of course, the representatives of the Geographical Societies of the various nations taking part in the Exhibition, who were mostly commissioners or delegates to the Congress.

In the Exhibition, as in the Congress, Geography was divided into eight principal divisions, each division being a group of sub-divisions. The classification of these divisions will be found at pages xii, xiii, and xiv of the General Catalogue.

The Exhibition was open to the public from the 1st to 30th September. The Congress commenced its sittings on the 15th and closed on the 22nd, and the Juries conducted their examinations and adjudgment of awards during the same week. The inaugural Meeting of the Congress, held in a large hall (Salle dei Pregadi) in the Doge's Palace, was conducted under the patronage of their Majesties the King and the Queen of Italy. The proceedings were commenced by Mons. Lesseps, as President of the 2nd International Congress held in Paris in 1875 and of the Permanent Committee who handed over the commemorative medal and the deeds of the second Congress to Prince Téano, the Pro-President of the third or Venice Congress. The proceedings consisted chiefly of congratulatory and complimentary speeches. The meetings of the eight groups of the Congress were held daily, in the forenoon, in the rooms of the Borsa (Exchange), and the meetings of the eight juries were held daily at all hours, from 8 to 3, in the various sections of the Exhibition. After noon, general meetings of the Congress were held in the Salle dei Pregadi, in the Doge's Palace, at which the proceedings in the group meetings of the morning were briefly recounted and questions of general interest were discussed and accounts of travels given by explorers.

It seems to me neither advisable nor necessary to cumber this report with any attempt at a detailed account of the Congress proceedings; but as it would scarcely be complete without some account of the proceedings, I am sending with it the "Diario," or official Gazette of the Congress, in 12 Nos.; also a document entitled "Elenco delle questioni presentate al III° Congresso Geographico Internazionale," with a separate appendix; and these will, I think, supply all the necessary information.

The following awards were granted to departments and individuals connected with India:—

Class I.—Survey of India. Letter of distinction. Colonel Haig, R. E., medal of the 1st class for his topographical maps of Guzerat.

Class II.—Survey of India. Diploma of honor, 1st class. Marine Survey of India. Diploma of honor, 1st class. Captain Baird, R. E., Medal of the 1st class for his tidal work and improvements in the self-registering tide-gauge.

Class VI.—Dr. W. W. Hunter, C.I.E., LL.D., medal of the 1st class for his "Gazetteer of India."

Class VIII.—Survey of India. Letter of distinction. A medal of the 1st class, and a medal of the 2nd class, to be placed at the disposal of Lieutenant-General Walker, C.B., R.E., Surveyor General of India, for award to the two Native Explorers whom he considers most meritorious.

I was informed, by the Secretary to the 3rd Section of the Organizing Committee, that the medals of the 1st class are to be of gold and those of the 2nd class of silver; and that they will be issued in about three months; but no statement on either of these points appeared in the "Diario." I should here mention that there were six kinds of awards, *viz.*:—

1. Letter of distinction.
2. Diploma of honor, 1st class.
3. Medal, 1st class.
4. Diploma of honor, 2nd class.
5. Medal, 2nd class.
6. Honorable mention.

The letters of distinction were only awarded to departments of States or Governments; the diplomas of honor, to the same and to Geographical or other Societies; and the medals, to meritorious individuals. Honorable mention might be awarded to States, Societies, or individuals.

Geography being so very comprehensive a science, the Exhibition of course contained many objects interesting to any general observer, and very many specially interesting to me; but I must here confine myself to those connected with our particular branch of geography, and on these I purpose writing a separate memorandum for your consideration. For instance, I noticed an important feature in all new theodolites,—the substitution of small circles with micrometers for larger circles with verniers. I also noticed two new patterns of theodolites, for explorers and preliminary triangulation; also a new volume of traverse tables, with an instrument to secure accuracy in reading them. I also took particular notice of the maps produced by the process called heliography, brought to great perfection by the Austrians; and I was particularly interested in relief maps, and a very simple method of constructing them, which I think might with advantage be adopted in the Topographical Parties of the Survey of India for the instruction of young surveyors in contouring. Nearly every country had an exhibition of relief maps—some in steel, others in copper, gypsum, india-rubber, and paper.

At the close of the Exhibition, I presented, with the concurrence of Sir Henry Thuillier, who left Venice on the 27th September, the following objects to the Royal Geographical

Society of Italy and the Chief of the Topographical Department. Those printed in italics were sent from the India Office :—

All the Indian Atlas sheets sent separately, to be hung against the walls.
Turkestan, 4th Edition.
Northern Afghanistan.
Southern ,,
Jamu, Kashmir, and adjacent districts.
Gilgit and surrounding country.
India (with hills), 1 inch=64 miles.
Eastern Bengal, Assam, and Burmah.
Town of Calcutta.
Ranikhet.
Simla and Kalka Road.
Simla and Jutog.
Eastern Kumaon.
Gwalior Fortress and City... 6 inches=1 mile
,, *Fortress* ... 24 inches=1 mile } in one map.
Town and suburbs of Rangoon.
Town and island of Bombay.

The whole of the geographies, geographical pamphlets, and maps sent by the Educational Department too late for exhibition.

Government of India papers on the Transliteration of Indian Proper Names.
Hunter's Guide to the Orthography of Indian Proper Names.
Papers of the Indian Government relative to the Cultivation of Cinchona.
The above were presented to the Geographical Society; the following, to the Topographical Department.

5 volumes of the Operations of the Great Trigonometrical Survey of India.
13 Synoptical Volumes of Trigonometrical Series.
5 volumes of annual Reports of the Survey of India.
1 volume of Auxiliary Tables.
1 ,, of *Saunder's Catalogue* of manuscript and printed Reports, Field Books, Maps, &c., of the Indian Surveys.

The Exhibition closed at 3 P.M. on the 30th September, when the work of packing up commenced at once; and on the 4th October all the cases were shipped on board the *Sumatra*, which was to leave Venice, for Bombay, on the 14th. The tidal instruments were consigned to Captain Hill, R. E., Poona, and all the other cases to the Superintendent of the Mathematical Instrument Department, Calcutta. The cases were not sent by the Steamer of the 7th October, because that vessel only plies between Venice, Brindisi, and Alexandria, and the cases would have had to be sent by rail across Egypt, which of course I avoided. The *Sumatra*, after conveying the mails to Alexandria, will come through the Suez Canal, and will land the Calcutta cases at Suez, for transhipment on board another steamer. I requested the Captain of the *Sumatra* to give special instructions at Suez regarding the careful handling of the cases sent on to Calcutta, which he promised me to do.

Thinking that the packing and shipping of the cases would take about a fortnight, instead of five days, I arranged with Captain Baird, soon after his arrival at Venice, that he should undertake this duty, and that I should be free to return to India by the first steamer after the close of the Exhibition, and I wrote to the Under Secretary of State, submitting this arrangement for Lord Hartington's approval; and in due time I received his Lordship's permission to return to India by the steamer leaving Venice on the 7th October. I accordingly left the packing and shipping of the cases chiefly to Captain Baird, after I had packed up the great theodolite; and Captain Baird so pushed on the work that he was able to leave Venice, for England, on the evening of the 4th October.

I consider myself fortunate in having been associated with two such colleagues as Sir Henry Thuillier and Captain Baird. Sir Henry Thuillier's intimate acquaintance with the Survey of India and his extensive knowledge of India generally, coupled with his kind, genial disposition and his readiness to impart information at once, gained for him the confidence and esteem of all with whom he came into contact. Captain Baird was most assiduous and energetic, not only in supplying information to those interested, but also in acquiring information for his colleagues as to the times and places of the various group and jury meetings, which was often very difficult to ascertain; and also in rendering any assistance, wherever it was required.

While at Venice, I made the acquaintance of many of the foreign commissioners and delegates, who presented me with books and pamphlets on scientific subjects, and French catalogues of their sections. Some of these were packed in one of the cases by Captain Baird before I had taken any memo. of them. Among them will be found a thick quarto volume giving the account of the voyage of the *Majenta* round the world, on scientific discovery. The rest I will forward to you, with four spare copies of the General Catalogue, as an accompaniment to the separate memo. alluded to in para. 25.

It was unfortunate that not one of the Indian Commissioners had witnessed either of the two previous Exhibitions at Antwerp or Paris; but it would have been impossible to have arranged otherwise. There was no Indian representative, that I am aware of, at the Antwerp Exhibition, and the late Colonel Montgomerie was the only representative at the Paris Exhibition of 1875. Owing to this, we were frequently at a disadvantage compared with the delegates from other countries: I therefore hope that the experience now gained may be turned to account at the next International Exhibition of Geography. The belief prevails that they will recur every five years, but where the next will be held is quite undecided; Stockholm, Budapest, Vienna, and London were all mentioned as likely and advantageous.

In this letter I must not suppress the fact that, although the Indian section drew much attention at both the Exhibition and Congress, and the Survey of India and the Marine Survey were well represented, still disappointment was expressed by many at the almost total absence of exhibits in classes III, IV, V, VI, and VII. It had been hoped by the promoters that one or more commissioners would have been appointed in India and placed in communication with all the Indian departments, and that they would have made the public aware of the coming Exhibition, and invited the co-operation of private individuals as contributors, and thus a large collection of objects in each of the eight classes would have been sent to the Exhibition. The Indian delegates were consequently often in an unpleasant position when asked the reason for the absence of exhibits of which it was hoped India would furnish an abundant and most interesting collection.

From England, there was almost no response to the invitation from the Italian Government, and I believe that, but for the appeals from the Ordnance, Survey, and the Admiralty for permission to send a contribution, England would have had no part whatever in the Exhibition. After these appeals had been granted, to the extent of sanctioning an expenditure of £100 to pay the cost of sending and exhibiting the contributions, five honorary Commissioners were appointed, who happened to be visiting Venice independently of Her Majesty's Government, *viz.*, Lord Aberdare, President of the Royal Geographical Society; Sir Henry Layard, G.C.B.; Mr. John Ball, Sir Henry Thuillier, and myself. This practically declared that the Government did not believe in any advantage accruing to England from taking part in such an Exhibition. This is a question which it scarcely becomes me to discuss here; but if any advantage would accrue to India from an exhibition of her geodesical and marine departments, I cannot but think that enhanced advantage would accrue were her many other departments similarly represented.

Memorandum referred to in above report.

I took special notice of the new theodolites exhibited in the various sections of the Exhibition, and I was struck with one feature common to all that were intended for accurate observations, *viz.*, greatly increased reading power micrometers in place of verniers were applied to quite small circles; indeed there were no graduated circles in the Exhibition, except our own, of greater diameter than 12 inches, and I ascertained that circles of 10 inches diameter are used in principal triangulation, giving results not quite so satisfactory as those of the principal triangulation of the Indian Survey, but apparently fully as good as those of the Ordnance Survey, obtained with Ramsden's 3-foot theodolite.

I was informed by a scientific French gentleman that the adoption of smaller circles with higher reading power is due to the perfection which has been attained in graduating circles. He mentioned many makers of repute in various continental cities who are possessed of dividing engines. There are four such engines in Paris, and the performances of these machines has been carried to such perfection that one of the Paris makers, having divided a circle for a customer, who thought the graduations not sufficiently deep, submitted the circle to a second revolution, the graver going over the same markings, deepening without widening them. It is evident that the approach to perfection in the graduation of circles must lead to the adoption of smaller circles with increased reading power; but it is also evident that the question as to the best combination of telescope power, radius of circle and reading power has not yet been carried to a conclusion, and it appears to me that instruments are made by the best makers in contravention of one rule dictated by very simple mathematics, *viz.*, that the power of the microscope or reading glass ought to be at least twice the power of the eye-piece of the telescope. We often find instruments designed so as to admit of their being furnished with large telescopes (for instance the Everest pattern theodolities) which are very comfortable to the observer, but without nearly sufficient reading power to enable the observer to record an observation with any thing like the accuracy with which it has been made in the telescope. In these instruments we frequently find the focal length of the telescope equal to four times the radius of the circle; but instead of making the reading power four times the telescope power, it is frequently the lower of the two; whereas it is evident that a small displacement of the telescope represented by the linear quantity d at the focus will only be represented by $\frac{d}{4}$ at the vernier, which therefore requires a magnifier 4 times as powerful as that at the eye-piece. Telescopes have never less focal length than the diameter of the circle, and the reading power ought never to be less than twice the power of the eye-piece. This appears to have been accepted by the makers on the continent, and they provide circles as small as 6-inch diameter, with powerful micrometers in their best new instruments.

Among the books sent with this, will be found a yellow pamphlet describing a universal instrument by Salmoiraghi of Milan, and I beg to draw attention to the engraving at the end of the pamphlet. The micrometers are so long that they present rather a clumsy appearance to an eye accustomed to the old-fashioned instruments. I point to it as it is typical of all the modern instruments exhibited.

There was one theodolite of Italian make that I greatly admired. It seemed to be of most perfect finish in every respect. The circles were about 6 inches in diameter, the telescope was attached to the end of the horizontal axis, a favourite feature on the Continent, and was about 12 inches in focal length. It had a novel contrivance for the micrometers, by which two eye-pieces sufficed for reading both circles. Each micrometer was T shaped, having two objectives, one to read the vertical and the other the horizontal circle. The arrangement secures a focal length for the micrometer equal to the diameter of the circle. This instrument had also a contrivance for adjusting the centering which I had not seen before. The foot-screws rested on a circular or annular brass plate, and a strong spring pulling the tribrach downwards guarded against displacement; but by relaxing the spring, the whole instrument could be moved horizontally in any direction on the plate till the centering was perfect when the spring would again be allowed to secure the instrument in its place. It also had a simple contrivance for measuring the height above the station mark simultaneously with the centering.

There were two interesting small theodolites for explorers: one in the French section made by Radiquet of Paris, exhibited by its owner—for whom it was specially made—Mons. D'Abbadie of note as an explorer in Central Africa and the author of a work entitled "Godesio de l'Ethiopie, instruments, publications diverses." The other was in the Italian section made by Salmoiraghi of Milan.

Mons. D'Abbadie's instrument was remarkable in having a prism in front of the object glass instead of between the object glass and eye-piece in the ordinary bent telescope, so that the entire telescope lay in a direction always perpendicular to that of the object, and for vertical angles the telescope merely revolved on its own axis. This gives a combination of stability and portability. The circles were about 4 inches in diameter, divided into 400 "grades" instead of the ordinary 360 degrees. Each grade was divided by the verniers into 100 parts, and the verniers were furnished with high-power magnifiers. Mons. D'Abbadie told me he has logarithm tables to suit this peculiar division, and that the reduction of observation is greatly simplified by this centigrade system. He has written a pamphlet entitled "Instruments a employer en voyage et Maniére de S'en Servir, par M. Antoine D'Abbadie, Membre de l'Institut. Extrait du bulletin de la Societé de Geographie (Aout 1878)," and in it he describes this little instrument and gives an engraving of it. One peculiarity of which the designer seemed proud is, the almost entire absence of screws, the foot-screws being, I think, the only exception. This might be a great advantage in a country where a screw could not be replaced. The instrument alone weighs 3½ kilogrammes, and when packed in its case, 5½ kilogrammes. The case is made to carry like a hand-bag.

Mons. D'Abbadie has given considerable attention towards remedying defects which make ordinary theodolites inconvenient for explorers and those who wish to travel with a minimum of impedimenta, and by his account explorers have hitherto found great difficulty in obtaining instruments suitable for their requirements. In 1839 (rather far back) he could not find a suitable instrument either in London or Paris, and had to content himself with one made by Pistor of Berlin; but so late as 1877, Major Serpa Pinto, the African explorer, and Mons. H. Capello, his Confrère, were neither of them able to suit himself with a theodolite in either London or Paris. There are several ingenious contrivances about this little instrument, and its owner seemed well satisfied with it and its results.

There were three theodolites by Troughton and Simms and one by Cook and Sons, made by direction of Captain G. B. Magnaghi, Italian Navy, and Director of the Hydrographic Department, who exhibited them. It was interesting to see, that, though these noted English makers are appreciated in Italy, the designs of the instruments, specially of those made by Troughton and Simms, were similar to those of the generality of new Continental theodolites, of which I have spoken generally above. I may here add that no theodolites, except our own, had more than two verniers or micrometers to one circle,—a feature which does not at all commend itself to me, though in an instrument *like* that described above, it would be unavoidable; but here I think the other beauties of design more than compensate for the loss of the third micrometer.

I took particular notice of the maps produced by the process of heliography in the Austrian section. They appeared to me scarcely inferior to engraved maps. The process is not nearly so rapid as photozincography, but much more rapid than ordinary engraving. The originals have to be very beautifully drawn on paper specially made for the purpose, so that as to results, time of execution, and cost of agency employed, it appears to be intermediate between photozincography and engraving. I could not obtain any specimens; but among the books I am sending will be found a pamphlet in German published at Vienna entitled "Die Technik der Reproduction von Melitar Karten und Pläuen, &c.," by Ottomar Volkmer, in which the process is compared with others. I make this slight allusion to the subject under the impression that there are officers in the department who have made a special study of the processes of map reproduction, and who will know much more about heliography than I could have acquired in my desultory studies at the Exhibition.

In the Topographical department of all the countries represented, great attention appears to be paid to vertical measurements, for which the common French name is Hypsometrie and the Italian equivalent Altimetria, though I am not aware that either Hypsometry

or Altimetry has yet been adopted as an English equivalent, although both words are in some form to be occasionally found outside ordinary dictionaries. Colonel A de Tillo of the Russian Staff has published a Hypsometric Atlas of the Russian Empire, containing sections, the aggregate length of which is more than 70,000 kilometres, derived from surveys of roads, railroads, and canals. The plane tables in most of the sections were furnished with leveling screws like a theodolite, and the sight rules were properly termed alidades, being furnished with telescope vertical circle and verniers, the ruler itself being highly finished in metal, sometimes silvered, on which the requisite scales were beautifully engraved, enabling the surveyor to make his map as complete with respect to vertical as to horizontal details.

I was also struck with the relief maps to be seen in most of the European sections, except that of England. Of course they are common enough in scientific museums and military institutions in England, but in other countries they seem to have been much popularised of late and to be much used in educational establishments. In the packet of books will be found a German paper and advertisement about the preparation of relief maps in India-rubber (Gummi-Relief Karten), of which many were exhibited in the German Section; and they appear to be made at small cost. A very common way of making relief maps, particularly those used for purposes of tuition, is merely to cut up a contoured map, going over each contour with a penknife, and at the same time cutting out a duplicate coupon from a piece of paper placed below it.* Paper is made for this purpose of various grades of thickness to suit various vertical intervals. When every contour with its duplicate has been cut out, the map from which they have been cut is pasted on to another sheet of paper and the blank coupon corresponding to the first contour is pasted into and of course just fills up the part of the map cut out: then the first contour is put back in its proper place, its outer edge being adjusted to the periphery of its coupon and pasted to it, leaving the interior of the coupon ready to receive the second coupon which is fitted in like the first, the second contour being then attached to it followed by the insertion of the third coupon and so on till the top contour has been pasted on to its coupon. When the contours run very close together, two or three maps must be cut up and the successive contours cut from different maps, and so very delicate strips are avoided. The process is so simple that I purpose making a relief map from one of our Dang Sections for the instruction of the Sub-Surveyors.

* That is from a separate piece of paper placed below each successive contour, so that the coupons are not rings but discs.

The last object I have to mention was exhibited in the Victoria Collection. It was a new book of Traverse Tables by Mr. W. Crellin, an authorised Surveyor in the Crownland's office at Melbourne. Co-ordinates are given to four places of decimals and to every minute of the quadrant. The cost of the book is £3-3, and with it can be purchased for an extra £1 an instrument for insuring accuracy in the abstraction of the co-ordinates. It is made in electrum, and consists of a rectangular frame containing a series of straight keys numbered similarly to the column of distances. By placing the instrument over the sines and co-sines pertaining to any given direction or bearing, and turning over the keys corresponding to the units, tens, hundreds, &c., in the given distance, the required sines and co-sines are discovered; and none but those required being visible, they can be added together at once without extracting and totalling on a separate piece of paper. The tables are well arranged, and well printed and got up. A printed advertisement and paper of testimonials as to the value of the book will be found in the packet of books sent herewith. It is somewhat remarkable that Shortrede's and Boileau's Traverse Tables would appear to be unknown in Australia where so much traverse surveying has been carried on. Mr. Gurden, an authorised Surveyor under the Victoria Government, who brought out a book of Traverse Tables last year—also giving the co-ordinates to four places of decimals and to every minute of the quadrant—compares in the preface to his volume the method of reducing a traverse by means of his tables with the method by using tables of logarithms. Mr. Crellin and the gentlemen who have given him testimonials do the same thing as if no other traverse tables were in existence. Mr. Gurden would appear to be aware of the existence of other tables from the last clause on the first page of his introduction, but his comparison on the third page seems clearly to indicate that the only method of reducing traverses practised in Australia was the logarithmic. The advantage of both his and Mr. Crellin's tables is, giving the co-ordinates to one more place of decimals than any previous traverse tables, and giving them to every minute instead of to every two minutes.

Extract from the Narrative Report, dated 1st October 1881, of LIEUT.-COL. B. R. BRANFILL, B.C., *Deputy Superintendent, Survey of India, in charge Bombay Party.*

Although so much of the country traversed by the Eastern Sind series is a dreary wilderness of sand, it is not entirely devoid of interest, from the fact that it may only in comparatively recent times have become desert, and being in a continual state of motion, it is probably spreading in the direction of the prevailing wind during the dry and hot season. That part of the desert was not always so, appears from the existence of many ruined places within its borders, and from the change in the bed of the river Indus from east to west within historic times. This westerly tendency of the river bed has been attributed to the natural "set" to the westward of a north to south flowing current in the Northern Hemisphere, due to the increasing velocity of diurnal rotation of the parallels which it successively crosses; but a more effective cause of change may be found in the prevalence of westerly or south-westerly

over easterly or north-easterly winds, especially in the dry and hot months of March, April, and May, when the sand of the river channel is transported continually to the eastward, tending to fill up the more easterly channels and to protect their eastern banks from erosion by the water of the ensuing inundation, besides going to increase the actual amount of drift sand in the desert to the eastward. However this may be, there is no doubt, that many towns and villages have been deserted by the rivers which once watered them. The ruins of some of these, and traces of the river channels on which they were built, are still met with, especially on the west and northern edges of the desert where the sand has not yet quite obliterated them; but most of them have probably been overwhelmed and lost in the ever moving flood of sand from the south-westward.

Several rivers between the Jumna and Sutlej, such as the Saraswati and the Ghaggar, have for centuries lost themselves in the northern parts of the Great Indian Desert. Traces of their channels also, like those of the Indus and its tributaries, are reported to exist in the desert, with the ruins of deserted towns that once flourished on their banks. Bahâwalpur is said to be especially rich in these remains.

The principal ruins met with by the party this season were those of Vijnôt and Sirwâhi (or Seorâî). The former is a collection of blackened mounds, from 10 to 20 feet in height, consisting of the debris of bricks and pottery mixed with earth, and comminuted pieces of charcoal, indicating the site of a considerable town, extending over half a mile in length and nearly a quarter of a mile in width. Exclusive of suburban mounds, the site now measures a mile and a half in circumference. The only tradition about Vijnôt amongst the country folk that I could learn is, that it was one of the five (or seven) chief cities of Sindh in the early days before the Muhammadan conquest (711 A.D.). The place lies about half a mile east of the Rênî Nadî, an old channel of the river Indus, and about 4 miles south from the Rêtî station of the Indus Valley (State) Railway.

That Vijnôt was an ancient city of importance, is proved by the present height of the mounds, the base of which has been silted up to a depth of 4 or 5 feet or more of alluvial deposit, left by numberless inundations, by the vast quantities of very large sized bricks (15″ to 18″ long, 9″ to 12″ wide, and 3″ to 4″ thick), similar to those found in the ancient Hindu cities of India; and, thirdly, by the remains of a Hindu temple in the middle of the place, partially built or faced with sand-stone that must have been brought at a great expense from the nearest quarries in Jesalmer across the desert (if the desert existed then). The ruins have been used as a quarry for stones and bricks perhaps for centuries, and only a few fragments of stone sculptures remain to show the style of art that the temple belongs to, which appears to be mediæval Hindu, but nothing has been secured that fixes the date with any precision. Beads and the fragments of other ornaments are picked up on the surface of the mounds together with diminutive copper and silver coins, the figures on which are too much obliterated to yield any results of significance.

The other old place met with was Sirwâhi or Seorâî, the site of a lofty fort, close to a town, also said to be one of the ancient fortified cities of Sindh, situate about 5 miles north-east of Sabzalkot, and 3 miles north-west of the Walhâr Railway station (Indus Valley State Railway) in the Bahâwalpur State. The fort is about a quarter of a mile in circumference, and 50 feet high above the great plain around it; whilst the mound on which the adjacent town stood, is perhaps half to three quarters of a mile round and 20 to 30 feet high.

The walls of the fort are still precipitous, although in ruins; for it is only during the last few years that the escarped revetment has been taken away to make ballasting metal for the Indus Valley State Railway. The few remaining brick-bats show that the large old-fashioned bricks were used here, as at Vijnôt; and the base and capital of a small stone pillar, said to have been found amongst the ruins of the fort, remain to indicate that the same style of art may have prevailed here as at Vijnôt. A few beads, &c., were picked up, and some fragments of pottery-ware, ornamented with obsolete patterns precisely similar to those of Vijnôt and other ancient sites adjacent. Some earthen-ware balls were also found about the size of a man's head, that may well have served the purpose of round-shot for ancient artillery.

Extract from the Narrative Report, dated 9th September 1881, of CAPTAIN J. HILL, R.E., *Officiating Deputy Superintendent, third grade, in charge of the Eastern Frontier Series.*

Mr. J. F. McCarthy.

In my Narrative Report for 1879-80, I stated that I left Siam finally on the 12th April 1880. From that date the completion of the Bangkok Series entirely depended upon Mr. McCarthy. Since I left Siam, he has finished the observations of the Bangkok Series, the last station of which is in Bangkok, on an artificial eminence called Phu Khao Thong, situated within the enclosure of the Wat Saket Monastery. He has also determined the positions of the towns of Pechaburi, Thacheen, Paknam, and Meklong, by triangulation, his observations being taken whenever breaks in the rains allowed of observing. The towns of Kanburi and Ratburi were previously connected with the triangulation, so that the positions of six important towns (exclusive of the City of Bangkok) have been well determined. One of the stations of the triangulation is also on the celebrated Phra Pratom Pagoda, the largest in Siam. The outside measurement of its quadrangular enclosure is 3,251 feet. Within this enclosure, which is cloistered and turreted, are other cloisters and temples and belfries, built on successive plateaux from the centre of the highest of which the great bell-shaped spire springs, and rises to a height of 347

feet above the general surface of the ground surrounding the enclosure. This height does not include the large metal ornament at the top of the spire. The small town of Phra Pratom, where the pagoda is situated, lies 30 miles to the west of Bangkok, and is of some importance as it contains one of the King's numerous palaces; and its annual fair is one of the chief events in the country.

In addition to these important places, the secondary work of the Series comprises a large number of intersected points, and embraces the considerable area of 8,033 square miles. Hill peaks on both sides of the head of the Gulf of Siam have had their positions determined by Mr. McCarthy, and compass sketches have been made of the chief rivers and canals within the limits of the triangulation. The route from Phra Pratom *viâ* Kanburi to the Natyadoung Pass was also measured with compass and cane ropes. Mr. McCarthy has also prepared a chart of Bangkok, on the scale of 4 inches to the mile, which represents a considerable amount of work. The positions of the principal objects there, such as Wats (monasteries), pagodas, and most important flag-staffs, have been determined by triangulation, and the principal details by chain and compass. A Siamese gentleman, named Loung Na Ra, was Mr. McCarthy's assistant in this work. He was attached to Mr. McCarthy by the Siamese Government, and took a great interest in surveying, and learnt a great deal. He did the chain and compass part of the work in the town, which for several reasons it would not have been prudent for Mr. McCarthy to be seen doing, and his work was daily tested against the values obtained by triangulation. Certain parts of the survey of the town was also checked, and distances obtained by Mr. McCarthy with a perambulator.

The following is a brief account of Mr. McCarthy's proceedings after I left Siam:—

His first business was to finish the main triangulation to Bangkok, with which object he set about erecting a 25 feet braced stand for his theodolite to be used at the high station of Phu Khao Thong, the additional height being necessary to see over some distant forest between Bangkok and Phra Pratom. There was much delay in getting this stand made; but after consultations with the Minister of Foreign Affairs and the Lord Mayor, and after the special sanction of the king had been obtained, the stand and necessary scaffolding were erected on the 21st April 1880. When this was done, he went to Ratburi to remove the native establishment and elephants to Phra Pratom, which was the most convenient place to house them for the rainy season. After seeing them established at Phra Pratom, he set about the preparation of a second station on the pagoda there at a greater height than the original station. A ladder of bamboos was made and fastened by iron spikes to the surface of the bell-shaped spire, and by it he reached a lofty ledge near the top, from which he succeeded in taking the requisite observations. He then went to the Nakhonchaisi chimney, the top of which had been prepared as an observatory, as described in my last Narrative Report, and thence to Bangkok, thus finishing the last triangle by which the position of Bangkok has been determined. The rainy season commenced towards the end of May and ended in November, and the triangulation to the towns, &c., lying near the main triangulation, which involved a good deal of jungle-cutting, was carried on with difficulty; for the Siamese, who are not fond of work at any time, pleaded the rain and the flooded state of the country as an excuse for giving very little assistance. He persevered, however, and succeeded in determining the positions of many useful points, such as pagodas, hill peaks, and the towns already mentioned. Throughout the month of June Mr. McCarthy was engaged on secondary work to the south and south-west of Bangkok. During July he was employed chiefly on the survey of the city. On the 8th August he heard reports that the native establishment at Phra Pratom, who were under the supervision of the native doctor (Hashmut Ali), were not conducting themselves well, and he went there at once to investigate matters. After doing this, he returned to Bangkok to consult with Mr. Newman at the Agency as to what he had better do. This resulted in his going back to Phra Pratom on the 14th August and remaining there until the 17th September. During this interval he was chiefly employed in plotting the measurements taken in Bangkok. From the end of September to the last week in October he was engaged on secondary work, in connection with Ratburi, Pechaburi, and Meklong; after finishing which he returned to Bangkok, where I wished him to take astronomical observations for Azimuth. The king was then, however, performing the annual ceremony of visiting the Wats (monasteries), and the station on Phu Khao Thong in Wat Saket was not available until the 3rd November. Mr. McCarthy then took up his quarters at the Wat to observe the Azimuth, but clouds and rain hindered him from doing any work there, and on the 7th November he left the Wat to make his arrangements for returning to Burma, in order to take the observations at the origin of the Bangkok Series, which Mr. H. Beverley was unable to take during his last field season. At this time he was requested by Mr. Newman, Her Britannic Majesty's Vice-Consul, who was in charge of the Agency, to accompany a Siamese telegraphic expedition, then about to start for Natyadoung, a Pass on the British Frontier, about 55 miles higher up the frontier than the Amya Pass, by which we entered Siam from Burma. I give Mr. McCarthy's account of his movements, from this time until he rejoined me, in his own words.

"I was now requested by the Vice-Consul, Mr. Newman, to accompany the Siamese telegraphic expedition that was about to start to the Natyadoung Pass. As this was represented as a special kind of work, to be carried out with the greatest despatch, and as I was still in Siam and it yet required a great deal of assistance from the Siamese authorities, in the way of securing supplies, &c., before I could safely get beyond the Karen Hills, I thought it advisable, backed as the matter was with the special request of the Consulate, to accompany the expedition, but I did not anticipate the delays that ensued, otherwise I most certainly should not have gone."

"On the 11th November I left Bangkok, accompanying Mr. Davidson, the officer in charge of the Siamese telegraphs, to consult the Regent at Rathuri about the proposed line, and on the 16th reached Phra Pratom.

"Preparations were now being made for collecting supplies and carriage, and on the 21st we left Phra Pratom, and with compass and chain ran a traverse along the "Than Somdeth" (or Regent's Road) to Kanburi, which was reached on the 24th. *En route* Phra Pratom was visited, and some magnetic bearings to surrounding trigonometrical stations taken.

"On arriving in Kanburi the Governor was in a dying condition, and great confusion prevailed in every direction; nor did any way out of the difficulties present itself, as those mostly responsible were with evident signs of anxiety awaiting the end to know how their positions were to be improved thereby.

"On the 30th November, at the request of the Governor, I accompanied Mr. Davidson to Rathuri, to see the Regent about procuring some elephants.

"On the 4th December, having returned to Kanburi, I visited Khao Phu-Rong, a small hill north of the town, and took some magnetic bearings. I also took measurements for determining the discharge of the united streams, Khuai-Nai and Khuai-Yai, opposite the town. By the 12th my patience was exhausted, and Mr. Davidson and I started off without the Siamese, leaving them to follow up by river at their convenience.

"We reached the Natyadoung Pass on the 27th. The whole way was measured with cane ropes, and I was able to get magnetic bearings to known peaks from different points on the route, besides finding names for some of the peaks already fixed. Barometrical readings were taken at every place of any importance, besides magnetic bearings at the Pass itself.

"We returned from the village of Chiyoke by boat, and reached Kanburi on the 5th. I started the main camp for Ban Kamteea, while I started off for Hip-Nam to observe an angle that had been omitted. I left Hip-Nam on the 12th, and on the 16th January reached the Amya Pass.

"On the 18th January measurements for the discharge of the river at Amya were taken, and on the 22nd I was at Kiku L. S., but the haze, which was exceptionally heavy this season, hid everything from view, and it was not until the 1st February I was able to secure the observations required."

Mr. McCarthy had left Moulmein for the field on the 5th November 1879; he returned there on the 13th April 1881, having been employed on field duty for just a week over 1 year and 5 months. During the whole of this time he carried on his work to my entire satisfaction, and with regard to his relations with the authorities and others in Siam, Her Britannic Majesty's Consul, in charge of the Agency at Bangkok, when acknowledging his report of the completion of the Siamese portion of the work, wrote:—"I have much pleasure on this occasion in remarking upon the highly satisfactory manner in which, while in charge of the Survey Party in this country, you have conducted affairs in relation to the local authorities and natives generally."

In former reports I have described the country triangulated in Siam, and Mr. W. Beverley has described the country through which the Cape Negrais triangulation passes. A full description of the Mergui district is contained between pages 383 and 415 of the second volume of the *British Burma Gazetteer*, so my remarks on the country in the neighbourhood of the base line and the principal triangulation may be brief.

The part of the Mergui Island, where the base line has been prepared, consists of flat alluvial land, a great part of which being under cultivation is open and free from jungle. This land is a good deal cut up by creeks, and varied by numerous isolated hills which are covered with forest. The locality is chiefly remarkable as showing signs of a much larger former population. There are many small old pagodas scattered about; some in ruins; others, such as the Zetawon Pagoda, in tolerable repair, and still resorted to by the people. A number of Mussulmans, chiefly descendants of men from India and the Straits, who intermarried with the Burmans, have taken up their residence in this neighbourhood. They are increasing steadily and supplanting the original Burmans; and shortly before we commenced work, a small monastery, near the site of the western tower of the base, was abandoned by the monks, who said they could no longer live in the place, as there were no people left to feed them. Mr. Pocock was allowed to make use of this little monastery as the base line head-quarters, and it will probably be so used again next season. The Mussulmans of this neighbourhood speak Hindustani as well as Burmese. The climate is good and healthy. There is easy communication with Mergui by water from both ends of the base line; moderately good shooting is to be had; and altogether it is a pleasant place.

During the season under notice, the principal triangulation entered the complicated system of islands forming the main part of the Mergui Archipelago. To the north, where we had stations on islands, the navigation was open and easy; but the part of the Archipelago now reached, consists of thickly studded islands, interspersed with shoals and rocks, among which the tides run in all directions, so that the navigation is sometimes tedious, and requires care and watchfulness. The climate is salubrious; the scenery very beautiful, and many of the islands are peculiar and interesting. One little island south of Mergui, which looks from outside like a solid rocky island, can be entered in a boat at low water by a hole or short tunnel, after passing through which one finds one's self in a basin enclosed all round by walls of rock. When the tide rises, the only entrance is closed, and connection with the outer world is cut off until the tide falls again. About 3 miles east of the centre of the line joining Kapa Toung H. S. and Yajeo Toung H. S. is a small flat island named Tho Bya, covered with jungle, in the centre of which is a fresh water lake or natural tank, round the margin of which, until very recently, a

village stood and fields were cultivated; but tigers came and multiplied to such an extent that they drove away the people, and the island is now deserted.

Violent storms of circumscribed area appear to occasionally visit the Archipelago, and probably occur before the burst of the south-west monsoon. Mr. Potter, describing a station he selected on the island of Kissering opposite the mouth of the Le-Gnya River, says:—"This island, some 8 or 10 years ago was visited by a terrible storm, and the whole of its forest, except a tree here and there, was blown down; huge fallen trunks now lie strewn on the ground, making some places impassable, and, where an entrance has been effected, making progress slow and tedious. A young forest of about 8 years growth has replaced the fallen trees from the swamp which borders the sea to the top of the hills, and the whole is one tangled mass of trees and creepers." The Gazetteer states that this island was deserted by its inhabitants when the country was conquered by the Burmese, previously to which, "during the Siamese rule, it was well cultivated, and there was on it a large town of the same name, of which only large heaps of bricks remain to attest that it must have been a place of some size."

The Selung.

With the exception of fishing people from Mergui and its neighbourhood, who visit the shores of the islands and live in temporary sea-side villages during the fishing season, returning to their homes in the early part of April, the only people who now inhabit the Archipelago are the Selung, a small tribe of strange, timid, wild beings, without fixed abode. Descriptions of them are given at pages 405, 406, and 627, 628 of Volume II, *British Burma Gazetteer*. Although they are beginning to show less dread of their fellow-creatures than formerly, and a few of the least timid sometimes visit Mergui and the villages on the coast for purposes of barter (for they do not use money), it is still not easy to get into communication with them. Those who come to barter their goods, clothe themselves after a fashion in the coarsest cloth, obtained on some former visit from the Burmans; but they are not supposed by the latter to trouble themselves with clothes except on such occasions. Out in the Archipelago fleets of their boats may often be seen; but they fly at the sight of a strange boat, and disappear with wonderful speed. They live almost entirely in their boats, though they make rude shelters in trees and on poles at some of the islands to protect themselves in the rainy season. One of their head-quarters is on the island of Don (marked Ross Island on our charts), and I was told by a Burman who trades with them, that in the large island of Lampee, to the south of the Archipelago, there are Selung of a more civilised kind, who live in a large village, the ground round which they cultivate, and who dress like Burmans, some of the more wealthy actually wearing silk *putsoes*.

Some of these strange people touched at the village of Yajeo on the west coast of the island of Sellore on the 24th March, when I was observing at my station of Yajeo close by. When I heard this, I asked one of the headmen to try to induce some of them to come up to the station to see me. He promised to do so, and though their hearts failed them on the way up, and they tried to go back, he succeeded in bringing one man, two women, and their children, into my camp on the top of the hill. They were in a painful state of fright at first: the women began to cry, and none of them would raise their eyes from the ground. After a time, however, they became re-assured, and when a feast was made for them and for all the Burman men, women, boys and girls, who came up with them, the whole party enjoyed themselves very much, and the visit turned out a great success. The Chinese, from what I could learn, appear to fleece the Selung systematically, by sending agents to them out into the Archipelago in boats laden with rice, opium, arrack, &c. Each agent attaches himself to a batch of the Selung, and sticks to them wherever they go, bartering his rice, &c., at exorbitant rates for their pearls, shells (which fetch very high prices in China), bees-wax, mats, &c., and hindering them by every means in his power from dealing with any one else who might give them better terms. The people I saw complained of this; but could not understand how they could make any better arrangement. The Selung do not pay any revenue to Government, and, if I am rightly informed, an attempt made to take their census while I was in the field, was unsuccessful. The people at Yajeo told me that the Burman enumerator passed their village in a boat, flying an imposing flag to mark his importance. If he failed under such circumstances it was no wonder. Every Selung would have taken to flight on seeing a boat so decorated, approaching.

Extract from the Narrative Report of MAJOR C. STRAHAN, *in charge, No. 1, Topographical Party, Gwalior and Central India Survey—Season 1880-81.*

Remarks on the country plane tabled.

The country surveyed was very intricate indeed, almost more so than any we have as yet encountered. The large ranges of hills run, as a rule, nearly North and South, but they are themselves in many cases much broken up and irregular, whilst the lower hills are very complicated.

Roads.

It may be said that roads do not exist; the best is that from Kherwára, through Kotra to Roherá; but even this is so small and ill-defined that a guide is necessary, or a stranger will infallibly lose his way. In such a country it is needless to say that carts do not exist; bullocks and donkeys are the only beasts of burden ever met with, although I have more than once seen large herds of breeding camels belonging to the Maharana of Oodeypore grazing in the large valleys. Moving about even with a light camp is very difficult, unless your road hap-

pens to follow a valley; even under the best circumstances I never found it possible to send on a portion of the camp by night, nor could I myself ever go out of a foot's pace from the absolute necessity of keeping a guide with me. A Bhil's notion of distance, too, is of the vaguest, and they are very apt to grossly deceive you—unintentionally I think—as to how far off a place is. When first marching about such a country, and before one has had a little experience of the passes, and other obstacles likely to be met with, it is by no means an uncommon thing to lose your camp altogether, or perhaps have to bivouac until the camels can struggle in after dark with the help of torches. Even along the valleys it is not always plain sailing; for although you have no high passes, still the road is at best very rough, constantly passing over small hills or crossing streams with broad rocky beds. To the detail surveyor these difficulties are not so great, as his camp moves but very short distances at a time, and in all probability he is enabled to reconnoitre the road ahead of him, and perhaps can even get it made a little more passable for his camels; but then, again, he almost always has a hard walk to and from his work, especially in the big ranges, where water, which is an essential for the camp, is usually only to be found in the valleys: horses are useless, or almost so: and as the heat towards the end of February and throughout March gradually increases, the labour of constantly ascending and descending these rugged hills, and forcing one's way through and under the jungle, becomes greater and greater. The scenery is decidedly fine—the finest I have seen in India, away from the Himalayas; some of the gorges, particularly the three by which the Wákli flows through three large ranges, are very striking. The finest of all is that between Alsigarh and Gorána, known as the Wánkli Nál. I was also particularly struck by the immense size and great age of many of the Banian trees in the valleys.

Inhabitants.

Considering what a wild, uncivilised set are the Bhils, I think they behave very well to our survey parties; there is often a certain feeling of suspicion amongst them as to what we are doing, poking into every corner of their country; but in most cases a little tact gets over that, and then even if they are not exactly willing to help, at all events they do not actually molest us, beyond perhaps constantly pulling down our poles. Very little, however, serves to really arouse them, and then it is not so easy to quiet them down again. Mr. Templeton passed an unpleasant half-hour amongst them, when at work in the Pál of Mándwa; he had occasion to send a chain line to a hut some 200 or 300 yards from his plane table, which aroused the anger of the occupant, who rushed out and raised the "Kilki," or war cry, and in a moment Mr. Templeton and his men were surrounded and separated, he himself being hustled off farther into the centre of the Pál, the men around him threatening him with drawn swords and bows and arrows. Fortunately they did no more, and, at the intervention of some women, they let them all go,—a friendly old woman warning them not to come back at peril of their lives. This portion of the work was afterwards surveyed by Mr. Templeton, the Rao of Jura himself remaining with Mr. Templeton's camp, until the ground round these two Páls was finished. On another occasion one of the Mewár sowars and a sepoy were attacked, and a good deal knocked about, the sowar having his head badly cut open.

Rivers.

The rivers flowing through the season's work were the Wákal, the Sai, and the Sábatnatti (these two latter names are more commonly pronounced Hái and Hába, or Hápal). They all join to form the Sábamatti, which flows by Ahmedabad; they are mere mountain torrents, flowing down broad, stony or rocky beds, with patches of sand as they get farther south, until at last the bed of the Sábamatti becomes, as far as I have seen it, principally sand.

Cultivation.

Such a country as I have described, and with such inhabitants, is naturally not highly cultivated, still a considerable amount of wheat is grown in the cold weather; and in one valley, where there happened to be several villages inhabited by Brahmins, I saw the finest wheat I think I have ever seen in India. The cold weather crops are nearly always irrigated by small canals from the streams. The Bhils are decidedly skilful in laying out and making small irrigation channels. I also saw one or two fields of opium, but the results were very bad; the soil is evidently unsuitable. Turmeric, ginger, chilly, and yam, are grown in several places. During the rains Indian-corn and "bajra" are extensively cultivated, and form the principal food of the country; the latter is grown on the hill sides, which are cleared of jungle with immense labour during the cold weather; the trees are allowed to dry where they fall, and the whole is then fired and the seed is dropped among the ashes.

Villages.

The principal villages we met with (towns there were none) were Jura, Ogna, Mánpur, Bikarmi, and Mairpur, in Meywar, and Roberá and Pindwara in Sirohi; the first three are the residences of petty chiefs calling themselves Rajputs, but in reality only Grásias, *i. e.*, the descendants of Rajput Chiefs and Bhil wives; they consist of a few mud huts, with perhaps one or two bania's shops, and in any other country would be hardly dignified with the name of village. The Bhils never live in villages; their huts are always separate and scattered all over a valley: one reason assigned for this is, that they become so quarrelsome in their cups that they dare not build their huts close to each other.

Passes and Defiles.

Attached to this report are two descriptions of routes, the one from Oodeypore to Roberá, and the other from Kherwára *viá* Kotra to Roberá; in the former will be found mention of the defile known as the Wánkli Nál between Alsigarh and Gorana, the Torna Ghatta between Ogna and Jura, the

Kapa Nál between Bhákel, Mándawa, and Chitria; in the latter will be found the Somghatti between Som and Mánpur, and the Warla Nál between Mánpur and Kotra. Besides these, there is a pass along which camels can get with a little difficulty from Patia, in the Ogna valley, through Pipalmál, Palsa, Ghata and Pándibor to Wikria, and thence into the Oodeypore and Roherá road. South of this, again, is the Kukraghatti from Ragogarh, a few miles north of Ogna through Mádra, Tepur to Mainpur.

This is not a very high pass, and the road might easily be made a fairly good one for beasts of burden; then from Ogna there is a direct road to Kotra *viá* Bilak, Konkli, and Mongap; this, too, is passable for camels, but might be much improved with but little labour.

Extract from the Narrative Report of J. McGILL, Esq., *Assistant Superintendent, Survey of India, in charge No. 2 Topographical Party, Khandesh and Bombay Native States Survey—Season 1880-81.*

The country surveyed embraces portions of the talukas of Bhusawal, Jalgaon, Pachora, Dhulia, Nasirabad, Erandol, and the whole of Jamner taluka. The country in sheets 6, 7, 20, and 22, is mostly undulating, and intersected by low ridges of hills, and plateaux and valleys well cultivated with most of the dry crops, such as "bajri," "jowari," "till," "orad," gram, and cotton; and in some parts, where the soil is suitable, wheat is grown. But, although wells abound in the country, little use seems to be made of them in growing cereals by irrigation. There is a reserve forest south of Jamner, which occupies about 1781·0 acres of country; but all the hill slopes and waste lands are covered with trees or shrub jungle protected by forest laws. The principal trees are teak, "mhowa" (*Bassia "Latifolia*)" "salai" (*Boswellia thurifera*), "babul" (*Accacia Indica*), "kher" (*Accacia Catechu*), and the bastard teak or palas. In the plains, the mangoe, neem, pipal, tamarind, bur, simal (*Bombax Malabaricum*) and babul, afford a grateful shelter under their umbrageous branches. In small gardens adjoining some large villages are grown guavas, plantains, and the pân or betel leaf. The only vegetables to be had are brinjals, sweet potatoes, and carrots. The portion of country lying between Jamner and Pachora is very well cultivated, and the soil being black, produces good crops of cotton, bajri, jowari, maize, gram, and many kinds of pulse. The villages are numerous, and some of them are large with thriving populations, chiefly employed in agriculture. The cattle of the country are very poor and small in size, and suffer very much from want of fodder, owing to the greater portion of the country being under cultivation or protected by forest laws. Insect life of all kinds swarm and cause much annoyance—flies, mosquitoes, scorpions, and centepides. The country in standard sheet 37, lat. $\frac{20°\ 45'}{21°\ 0'}$ and long. $\frac{74°\ 30'}{75°\ 0'}$, is hilly to the north and south-west; and although the villages are few, yet the country is under cultivation wherever available. To the east and west, and around the town of Dhulia, the soil is rich, water plentiful, and valleys broad and intersected by canals from the Panjbra river or from lakes. It is well wooded, and the trees are protected by forest laws from wanton destruction. The Laling Reserve Forest, of 7,900 acres, lies to the south-west of the sheet, and is covered with fine timber trees and nurseries of teak. The principal forest trees are the Anjan (*Hardwickia binata*) teak, palas (*Butia frondosa*), and other wild trees. During the month of March the country looks quite bright and gay with the bright red flowers of the palas. The hills in sheet 37 are mostly of friable basalt, and assume the peculiar fantastic shapes of basaltic hills. Four of them attain a considerable height, *viz.*, Laling 1,933 feet above sea-level, Suli-Beri (Anakwari, H.S.) 2,233 feet, Arvi hill 2,166 feet, and Devi Mata 2,105 feet. The country is much cut up with small streams and afforded rather tedious and difficult ground for plane-tabling, the more so as it was done in the hot weather with the thermometer at 125° in the sun.

Forts and towns.

There are no forts deserving the name in the work of the season. All towns have walled enclosures, either of mud walls or brick and chunam; in which are the houses of the headmen, or village officials; and every village has its citadel of mud walls flanked with towers, but most of them are in ruins. The large nim or tamarind trees growing on these towers offer excellent points for the plane tables.

The chief towns in sheets 6, 7, 20, and 22, are Bodwar, Jamti, Jamner, Nasirabad, Shendurni, Pimpalgaon (Buzurg), Lohara, Paldhi, Pahur, Neri, and Mehrun. In sheet 37, Dhulia, Ner, Kusamba, Kher, and Mukti.

The principal hills in sheets 20 and 22 are the Adjunta ghauts, a basaltic range which rises to a height of 2,346 feet above sea level, and 1,000 feet above the plains of Khandeish, and form a most imposing natural feature. There are two passes over these hills available for carts, the one by the town of Adjunta, which is the main road for troops marching from Secunderabad to the Railway Station of Nargaon, and from thence to Burhanpur; and the other is over the Raujangaon Ghât *viá* Kanar to Dhulia. The country above this range is a plateau of rich black soil, with a climate much cooler than the plains of Khandesh. About 4 miles south-east of the village of Fardapur, in a gorge of these hills, are the famous cave temples of Adjunta, called by the natives Lina—lat. 20° 35′ and long. 76° 12′—carved in the steep face of the hills which rise like a wall on either side to a height of 300 feet above the bed of the small stream below. On some of the commanding crests of the Adjunta hills are found strongly built forts, which are now falling into ruins. One of these hill forts, Baithalgarh, is still in very good preservation, and is garrisoned by a small number of Rohillas belonging to the Nizam's State. None of the other hills in sheets 20 and 22 are of any consequence, and none of them attain a height

more than 400 feet above the plains. All the hills are more or less covered with shrub jungle or forest trees. In sheet 37 there are some conspicuous hills, such as Laling, 1,964 feet above sea level; Suli-Beri, Walwari, H.S., 2,238 feet; Arvi hill, 2,166 feet; and Devi Mata, 2,105 feet. On Laling hill, which is about 960 feet above the plains, a bungalow has been built, which is resorted to by the officials in Dhulia during the hot season. There are some tanks for the storage of water on the hill which are cut out of the solid rock and afford a plentiful supply of good drinking water. Laling was in the old troublous times a large town, nestling securely under the hill fort; but nothing now remains of the old town but a few fragmentary ruins of its walls. The high road from Aurungabad to Dhulia passes to the south of the hill. Another remarkable feature in sheet 37 is a range of hills which runs almost in a straight line east and west for 17 miles, broken only in one part by a hiatus of 3 miles, where the Panjhra river forces a way through it. This range rises about 250 feet above the plains, and is about 650 feet broad at its base, and is of friable basalt. About 3 miles north of Dhulia these hills divide into two distinct ranges, running parallel with each other and only a few feet apart.

Rivers.

There are no very remarkable rivers in the portion of the country surveyed this season. In sheets 20 and 22 are the Girna, Waghur, Kag, and Surnady; and in sheet 37 the Panjhra river.

The Girna.

The Girna is a large river which rises in the Dang hills, in the Kalvan district of Nasik, and after running a course of about 160 miles, passing the towns of Malegaon, Mehun, Bargaon, and Mhasawad, falls into the Tapti river near the village of Palsoda, lat. 21° 9′, long. 75° 22′. It has high banks and a sandy bed, and in the hot weather it shrinks into a narrow stream of water about 3 feet deep and about 60 feet broad.

The Waghur.

The Waghur rises in the Adjunta hills, near the caves, and running a north-westerly course of 65 miles, falls into the Tapti river near the village of Shalegaon. During the dry months this river shrinks into a very small stream barely 40 feet broad and 2 feet deep. The towns on its banks are Pahur and Neri.

The Sur.

The Sur river rises in the Adjunta hills near the village of Deolgaon, and flowing north for 8 miles, forms the boundary between the provinces of Khandesh and East Berar. It then flows north-west 28 miles and falls into the Waghur near the village of Singait.

The Kag.

The Kag takes its rise in the Adjunta hills, about 3 miles south of the village of Gondri, and flowing north for about 9 miles, and then north-west for 15 miles, joins the river Waghur near the village of Mehenjal. The towns on its banks are Fatepur, Takarkhera, and Jamner.

The Panjhra.

The Panjhra rises in the Sahyádri hills near the village of Shenwai, in lat. 73° 59′ 30″, long. 20° 50′ 30″. It first takes a northerly course for 8 miles and then east, draining the Pimpalner and Dhulia valleys for about 56 miles, when it takes a north-north-east course of 26 miles and enters the Tapti river near the village of Murhawad. This river in its course of 90 miles helps to irrigate and fertilise a large extent of country by numerous canals fed by its waters. Gardens of fruit trees, sugarcane, and wheat, are seen along its banks, and these, with the fine shady groves of trees, give the country watered by it, a rich and pleasant aspect.

Lakes.

There are two very pretty lakes in sheet 37,—the Mugti lake, 3 miles south-west of Dhulia, about 1½ mile long by 1 broad, covering an area of 510 acres, which is formed by damming the small stream Mugti about 1½ miles from its junction with the Panjhra. This lake is almost encircled by hills rising about 150 feet above its waters. The Gondur lake lies to the north-west of the village of Gondur, and about 4 miles north-west of Dhulia; is formed by two dams connecting a hill range. This lake is 1½ mile long and ¾ mile broad. It is fed by six streams, which rise in the hills 2 miles north. In sheet 20 is the Mehrun lake, covering an area of 151 acres, built by the Jalgaon Municipality for supplying that town with water. The Hartala lake in sheet 6, covering an area of 440 acres, which helps to irrigate a large extent of country.

Inhabitants.

The inhabitants are chiefly Gujars, Kunbis, Mahratas and Mahomedans, and a small number of Bunjaras, Kolis, Mahars, and Mangs. The Banjaras having lost their occupation of carriers, owing to the Railway, are now gradually settling down as cultivators under their respective Chiefs as Patels.

The language spoken by the people of the country is Mahrati. The people are very fond of amusements, especially in the shape of Theatricals, and a class of strolling actors seem to make a good living by indulging the taste of the people in this respect. They are also rather addicted to drink, and as liquor is cheap (being distilled in the country from the flowers of the Mowha) they can easily indulge in this habit. They are careless and rather indifferent in their religious observances, and their temples are small and mean-looking structures, dedicated principally to Mahdeo or some Devi. At the entrance of most villages is a large stone, with an image of Hanuman, the monkey god, cut on it, well smeared with oil and red ochre. The houses are flat-roofed and built of mud, and this peculiarity of structure gives even the large villages a mean and sombre look.

The only antiquarian remains that came under my notice, are the rock-cut water tanks on the Laling hills, five of which are in fair order and contain a supply of good drinking water, and the remains of an old temple near the village of Garkhera in the Jamner taluka. This temple

was built of hard basalt, finely carved with figures of gods and goddesses in rows along the outer surface. These figures, which are exquisitely carved, are still in good preservation. The ruins of the old temple have been built upon by a modern structure of brick and mud, which is now dedicated to Mahdeo.

Extract from the Narrative Report of MAJOR W. F. BADGLEY, *Deputy Superintendent, Survey of India, in charge No. 6 Topographical Party, Khasi and Garo Hills Survey-Season 1880-81.*

Country plane tabled.

Generally, the country plane tabled was of a difficult nature,—of hills, forest, and swamp, with little open ground or clearing. Work is difficult in such ground, and of course slow; but from my own experience and from my inspection of the plane tables in the field, I am satisfied that as much was done as could be expected, and that it was all well done. The work in Hill Tipperah was of the same character. There were one or two large streams in it which were too deep to wade, and which had banks impossible to traverse on account of the jungle, which Mr. Chennell had to chain with boats. Besides the topographical work of this part, Mr. Chennell accompanied the Deputy Commissioner of Sylhet on the settlement of the boundary with Hill Tipperah.

Mr. Chennell discovered the much sought for Bongsuel or Vomsuel boundary pillar. It was on a spur of the Pathariya range, not on the range itself as had been supposed. Viewed from some point to the south, it may appear as a "well-defined and prominent peak," but seen from the north or east, the direction in which we have always approached it, it has nothing to distinguish it from the other spurs of the range. The iron (telegraph) post was found, but had been thrown down and broken by elephants. Mr. Jones in his report concerning the erection of this post, mentions that the broad valley to the east of the range and up to Chatachura Hill could be seen. I can only suppose that the range, whose forest covered ridge now shuts out the view of all but the top of Chatachura, must have been cleared for cultivation at the time of his visit. At present all the country for many miles from the point is entirely deserted, and the names even of the hills are known only by tradition. The whole of the low country drained by the Jiri between this range and the Hararganj range will shortly be an immense rice field; and as the soil is very rich, it will repay the cost of its cultivation well, which accounts for the anxiety of Hill Tipperah to get as much of it as possible.

Roads, rivers, &c.

There are some new unmetalled riding roads being made specially for the use of the planters in the district, and a local cess has been introduced, which it is to be hoped may bring about some improvement in the means of communication. Generally, at present, the traveller makes his shortest way across the fields of stubble in the cold weather, and in summer, that is, the rains, gets into his boat at his own door and goes wherever he wishes; but in spring or autumn, I imagine he has mostly to stay at home, as he is surrounded by fields on which he dare not set foot, and unless he is living near a large river, he cannot use a boat. This refers to the plains on both sides of our work across the Pathariya range (running north and south, about longitude 92° 15′) on and about which most of our work lay; there are two foot-paths and a riding road. The paths are impassable and the riding road dangerous for laden elephants. I nearly lost one, and another went temporarily mad in attempting it. The first fell and its load had to be cut off and carried for it, and the other had to be bound by ropes as if newly caught, and its load also taken off.

There are no large streams except the Jiri in the country under report, and this stream, like all the others in south Sylhet, is only navigable for the smallest boats (ten-maund boats) during the winter; during the rains it is deep enough for the largest country boats. The Hakaluki Howhar, a celebrated bheel (swamp or lake) of those parts, is to the west of the northern part of our work. In the rains this is a lake about 20 miles by 9, where lives are yearly lost, and which has been described by local native officials as "that dangerous stormy sea." In the winter it is passable in some places on foot, after a fashion. I crossed it once at that season.

I was up to my waist in water and weeds more or less for more than half of the time, and was in it from about eight o'clock in the morning till past ten at night.

The Pathariya range (long. 92° 15′) in its higher parts is uninhabited, except by some Tipperah squatters in a few small villages; but the lower hills on either side are being taken up for tea cultivation, more and more, yearly. Outside the hills, on either side, there is a large population in the plains country. The country surveyed on the half-inch scale in Hill Tipperah is at present only inhabited at its northern end, but will, as I have said, soon I think, be opened up.

We had, as usual, difficulties (the reasons for which I am unable to make out) in procuring rice at the bazars. On several occasions, some person having influence with the sellers would induce them to refuse to sell to my men at any price, and even incite them to riot and attack them. Fortunately the principal offender in this way, who was a large land-owner in those parts, took occasion to pay off a spite against a neighbour by breaking into his house and half murdering him and his family, when the civil power took him into safe-keeping and we had comparative peace.

Extract from the Narrative Report of MAJOR G. STRAHAN, R.E., *in charge Mysore Topographical Survey—Season 1880-81.*

Standard sheets 23 and 24, over which the triangulation extended this season, are, for the most part, covered with forest, except along a diagonal from north-west to south-east, which is fairly open. The Bababudan hills skirt the southern edge, and their flanks are a dense mass of almost impenetrable jungle, chiefly bamboo, inhabited by wild elephant, and bison, and in which the plane tablers will certainly experience great difficulty. I did not find it necessary to

penetrate it, as I could fix sufficient points from stations outside it. The Bhadra river runs nearly centrally through the two sheets, and will probably prove unhealthy to those engaged on the survey of it. The north-east corner of sheet 23 contains also a good deal of very tangled forest which may give some difficulty. No sub-surveyor will be capable of doing any part of either of them.

The country plane tabled this season varies very much in its nature. Sheets 27, 28, and 29, executed by the sub-surveyors, are, for the most part, undulating and open. Plane table fixings by the surrounding well-marked hills and other points are very easy, and the chain was consequently hardly ever needed. The only difficulty lies in a proper delineation of the undulations, which are very puzzling features to the sub-surveyors. When decided hills are met with, they seem to offer less difficulty, and certainly considerable judgment is necessary to decide whether the face of the country shows strong enough undulations to make it necessary to delineate them. This subject is more fully touched on hereafter. Sheets 19, 20, 21, 26, and 49, on which the European assistants were engaged, are of the same nature as those taken up last year in the Western Ghâts, that is to say, they offer almost every possible obstacle to the progress of a topographical survey. The forests are almost unexplored, and stretch in an unbroken line along the ghâts for scores of miles. It is difficult to get natives to enter them partly from superstition, and partly from dread of fever and wild beasts. Supplies are hard to procure, habitations few and far between, and communication difficult across wild and rugged mountains, rising in some places over 6,000 feet above the sea. The few open spots met with are generally patches of wet cultivation, deep down in the valleys, from which no points can be seen and along which it becomes necessary to drag a chain with the chainmen often half way up their thighs in mud. Horses and ponies are of little or no use, and the surveyors perforce waste many a weary hour in going out to and returning from work. Inexhaustible patience is the best qualification for surveying such a country,—a quality which I am glad to find strongly developed among the members of the party. A few excellent roads traverse the Ghâts, and so long as one's camp remains on these, nothing can be pleasanter than travelling about this magnificent region in scenery which can probably be excelled hardly anywhere in the world. A full description of it is published in the Gazetteer of Mysore and Coorg, and it will therefore be unnecessary to enter into any minute details on the subject. The same remark applies to the forts, cities, passes, rivers, &c., full information on which points may be obtained in that publication.

The question of scale of shade has been under very careful consideration during the season, and attempts have been made to obtain a number of additional heights (besides those measured with a theodolite and plane table bases) with clinometers. One of these instruments, as supplied in connection with Circular Order No. 59 of 16th November 1881, was given to each plane tabler, with instructions for use. Each man was directed to keep a tracing of his plane tabling, on which all clinometer work was entered, and the various rays shown; and, in addition, the numerical work was entered in a note-book kept for the purpose. The results, as at first obtained, were, I regret to say, disappointing. High winds prevail in Mysore through a great part of the working season, and a very gentle breeze, I found by my own experience, was sufficient to render the results obtained by these instruments so wild as to make them inadmissible even with the word "approximate" appended, being little, if at all, better than an experienced eye could obtain by guess. The sub-surveyors also experienced much difficulty in understanding their use, and much work has had to be rejected, owing to their having taken heights at unknown points whose heights they had omitted to fix by observations to known heights around. My experience of sub-surveyors shows that it is almost impossible to forestall all the stupid blunders of this kind that they are liable to make. I spent a good deal of thought on improving the instrument, and after many trials I arrived at a clinometer, of which I have appended a sketch to this report. This was tried by many of the assistants, and found to give results far surpassing those obtained by the former instruments. It is not nearly so liable to be disturbed by wind, as it offers so much less resistance; it adjusts itself, when in use, by simply hanging free, no clamping of plumb lines with the fingers being necessary, and the object to be observed is brought, as it were, into contact with the division on the instrument which measures its difference of level. A full description is given with the sketch. This, of course, no more prevents the occurrence of such blunders of sub-surveyors, as that noted above, than the old one, but these must be overcome by practice in its use, and for next season a more extended code of rules will be laid down for their guidance, and they will be orally instructed by a competent person as well. In fair weather, I consider, these new clinometers will give results within 26 feet to each mile of distance of the observed point. I select a few results, taken quite at random from the work of sub-surveyor Janki Dass, this season, who made a very intelligent use of it.

Distance of observed point in feet.	Resulting height of station of observation.
41,270	2,560
29,850	2,531
30,200	2,488, mean 2,526
29,100	2,714
11,850	2,819, mean 2,767
31,025	2,575
37,225	2,573, mean 2,574
11,650	3,512
7,500	3,485
22,125	3,464, mean 3,487
2,600	3,915
18,500	3,916, mean 3,916
17,775	2,551
21,900	2,606
7,850	2,505, mean 2,551

These are rather long distances at which to employ the clinometer, but such will occasionally be necessary in practice. Of course, heights thus obtained are distinguished on the maps by the abbreviation "App." after them, as they must always be far inferior in accuracy to those determined trigonometrically.

Extract from the Narrative Report of Major T. H. HOLDICH, R. E., *in charge of the Kohat Topographical Survey Party—season 1880-81.*

Having been granted three months' special leave from 30th October, I made over charge of the party to Mr. W. W. McNair from that date, the effective strength of the party consisting only of himself, and Sub-Surveyor Syud Ulla, the rest being either on leave or on special duty, as detailed per margin.

Major T. H. Holdich, R. E., Deputy Superintendent, on leave.
Mr. T. E. M. Claudius, Surveyor, on leave.
Sub-Surveyor Abdul Subhan, on special duty.
Sub-Surveyor Imam Bux, on special duty.
Sub-Surveyor Hira Sing, on leave.
Sub-Surveyor Atma Sing, on leave.

Mr. McNair proceeded to the field on the 6th November, after assisting in the final arrangement of the Afghan records in the Dehra office, and after arranging for camp equipment at Pindi; he reached Kohat on the 7th December, and commenced triangulation in the Kohat district from the western extremity of the Meranzai valley (about Thal) on the 17th January.

His object in selecting this portion of the district first was partly to meet the wishes of the Deputy Commissioner, whose request for a detail survey of the Meranzai valley was urgent, and partly to secure a connection between Major Woodthorpe's initial points for his Kurram series and the Kohat extension from the Indus valley series of G. T. triangles.

Adopting a side of the Kohat secondary triangulation for his base, he succeeded fairly well in establishing the connection with Major Woodthorpe's triangulation, by means of Khadimakht and Sangar, two points which were laid down as stations on the extreme west of his triangulation; and then, turning eastwards, he utilised the old points of the Kohat secondary triangles, fixed 30 years ago, all of which were sufficiently easily identified to determine the position of a number of intersected points for the plane tables. Having covered an area of about 1,200 square miles which he estimated as sufficient for the season's topography, he computed out the results of his triangulation in the field, and projected plane tables for the survey of the Meranzai valley. Unfortunately he contracted a bad attack of the fever that was then prevalent in the valley, and was obliged to return to Kohat after plane-tabling only 12 square miles of country; but he had set Syud Ulla who had hitherto assisted as recorder, to work, when I reached Kohat on 15th of February, where I was shortly joined by Mr. Claudius on the 17th.

I resumed charge of the party from Mr. McNair on the 15th, and having arranged for guards, &c., I left Kohat to continue the triangulation of the district on the 23rd; when Mr. McNair proceeded on leave, and Mr. Claudius took his place with the plane table.

I continued the same system of intersections as had been adopted by Mr. McNair. The old stations of the original Kohat extension were all recognisable. After visiting two or three stations east of Kohat, I returned by the advice of Major Plowden, with a view to taking part in a rapid excursion into the Bara valley by the Landuki pass, but our intentions were frustrated by continued heavy rain. This stormy condition of weather continued almost without intermission from February till the end of April, rendering all attempts to use heliotrope signals perfectly useless, and much interfering with the progress of the work. I continued triangulating south of Kohat until warned for service with the Waziri column on 15th March. I proceeded at once to Kohat, where I was joined by Captain Martin on the 17th, and, making over charge of the party to Mr. Claudius on that date, I marched to Bannu, and reported my arrival to General Kennedy on the 29th.

Mr. Claudius availed himself of all opportunities of reconnoitring from the high points along the frontier, and completed a considerable area of valuable trans-frontier reconnaissance, besides securing theodolite observations which may prove of value in combination with those of other surveyors, from a commanding peak called Kudumb and two other frontier peaks. He also fixed a number of heights scattered over the plane table area in continuation of those already determined by Mr. McNair.

On the 25th April, the party closed work and left the field.

The areas triangulated are as follows :—

	Square Miles.	
Mr. McNair	1,200	Total 2,000.
Major Holdich	800	

Mr. Claudius observed from three frontier peaks.

Plane-tabled :—

	Square Miles.	
Mr. Claudius	144	Total 398 on 1-inch scale.
Syud Ulla	242	
Mr. McNair	12	

Reconnaissance across the frontier on ½ inch scale by Mr. Claudius, 170.

The triangulation executed was of a character somewhat different to that of a regular topographical party, as may be estimated from the large areas triangulated in so short a time. No secondary triangulation (or at the most only a few triangles in extension to the west in order to secure a basis for the Afghan work) was necessary. The original stations of the Kohat extension from the Great Indus series were utilised for the purpose of fixing intersected

points. Of these the great majority consist of natural features, peculiar rocks, single trees, &c., requiring no artificial aid to distinguish them.

It was impossible to put up many poles as points for observation, from the difficulty of procuring wood; and it would have been useless, from the interference of the natives. The average is about one intersected point to 17 square miles. In an open country like Kohat this is quite sufficient, but of course a large number of supplemental heights will be necessary.

The character of the Kohat district is too well known to need description in a short report. On the whole, the work proceeded without difficulty or opposition: but much was undoubtedly due to the fact that our guards were drawn from frontier regiments recruited from the ground of survey.

Extract from the Narrative Report, dated 29th November 1881, of COLONEL C. T. HAIG, R.E., *Deputy Superintendent, 1st grade, in charge Guzerat Party.*

The country under survey during the year may be briefly described as follows:—

Sheet 77 is foreign territory, with the exception of the small village of Ucharpi of the Ahmedabad Collectorate, wtih an area of 0·9 square miles. Of this foreign territory, 28 square miles are under the Mahi Kanta Political Agency, 3 square miles belong to the Rádhanpur State, and the remainder is owned by the Gaekwar of Baroda. The Western Rajputana State Railway passes through the eastern half of this sheet from north to south. The country is a flat open plain with almost no drainage, a meandering little stream called the Rupen River, trending its sluggish way across the length of the sheet, is the only water-course in it. The only towns of any importance are, Mehsàna and Chausama, the head-quarters of the Waiwatdars of Mehsàna and Wadaoli, with populations respectively of 7,874 and 7,448.

Of sheet 33, 345 square miles were surveyed and reported upon last season. Of the area under survey this year, 89 square miles are British, 98 square miles Baroda territory, and 28 square miles, Rajpipla, one of the Rewa Kanta States. The western portion of the sheet is open, the eastern more difficult, and to the north-east of Mandvi, hilly and forest-clad. The principal town is Mandvi in the Surat Collectorate, with a population of 4,000 and a Municipality. A metalled road from Kim Railway Station, in sheet 14, runs to Mandvi, which is kept in good repair. A survey was made in 1867 for an irrigation project to improve the country between the Narbada and Tapti Rivers, but the work has had to stand over for the present. Several of the Bench Marks have been fixed by the plane tablers, and their levels, furnished by the Irrigation Department, and reduced to mean sea-level by means of the connection effected by the Tidal and Leveling party, 1877, will be inserted in the fair maps, the point common to the two series of levels being the level of the rails on the Tapti Bridge.

In sheet 34 the area under survey comprised 241 square miles British, and 314 square miles Baroda territory. The country in this sheet answers very much to the description given in paragraph 16 of last year's report for sheet 33. In the eastern plane tables the bases of the spurs of the Western Ghats are met with, disappearing in small knolls averaging 50 to 100 feet. The fall in the country being very gentle, and the soil a sandy loam, which offers no resistance to the drainage from the Ghats; the streams spread out and cut up the country. The main drainage in the northern half of the sheet runs into the Mindhola River, through its tributaries the Madhao and the Gabui. In the southern half the Purna River, which falls into the sea at Naosari, carries off most of the drainage, a number of little feeders forming one of its tributaries, the Jhankria River. The principal towns in this sheet are, Bardoli, a taluka town with a population of 3,900 and a municipality; Valod, population 3,800, the head-quarters of a Mahalkari; Kadod, population 4,100; Mota, population 2,800; and Sarbhon, population 2,300, all in the Bardoli taluka of the Surat Collectorate. In Baroda territory, Vyàra, the head-quarters of a mamlatdar, has a population of 3,700, and Moha, also the head-quarters of a mamlatdar, has a population of 1,400. The eastern half of the sheet is sparsely populated, fever and diseases of the spleen being very prevalent. The old route for troops marching from Surat to Dhulia and Maligaon passes through this sheet, but the road is not much used and almost disappears before the hills are reached. There are three other fair-weather roads, one from Naosari *viâ* Sarbhon and Bardoli to Mandvi and Songad, the second branching from the first at Sarbhon, *viâ* Valod and Antapur to the Dangs, and the third from Bardoli, *viâ* Vyára to Songad. The Baroda State has, within the last three years, taken up the conservancy of the Forest in the Vyára and Songad talukas, and the timber trade is being revived.

Sheet 17 was begun in season 1879-80, 49 square miles having been surveyed; the remaining 45 square miles were surveyed between the middle of April and the middle of May. The area in this sheet is all British territory, lying along the sea coast. There is a greater variety in the aspect of this sheet than that of any other under survey during the past season. The estuaries of the Ambika Auranga and Pár Rivers fall within its limits, and several large tanks add to the irrigation of the country. A portion in the north is salt waste, but an attempt is being made by an American settler, Colonel Ansell, to reclaim some of the land. His efforts have been successful so far that he hopes to have a large area under cultivation for the first time this year. The southern half of the sheet has an irregular ragged surface, and is intersected by small water-courses. The alluvium in the river beds produces every variety of crop, and as the tilling requires but little exertion on the part of the cultivator, every here

and there small strips of cultivation are met with. The chief places of note are the taluka town of Bulsar, with a population of 12,300 and a municipality, near the mouth of the Auranga River. It has a fairly good Bunder, and carries on a brisk trade, mainly in the timber from the Dang forests. The red clay found near Bulsar makes excellent tiles, which are in great demand in Bombay. The only other town of any importance is Pardi, a taluka town with a population of 4,800 and a municipality. Tithal, although only a small village in itself, with a population of 380, is a small sanitarium; during the hot weather visitors come from stations in Guzerat and Bombay, and a small detachment of convalescent soldiers from Ahmedabad and Baroda, but many of the usual visitors now take advantage of the Western Rajputana State Railway and go to Abu. The Bombay, Baroda, and Central India Railway crosses the sheet from north to south, and has stations at Dungri in the northern half, and Bulsar and Pardi in the southern half. The hill fort of Parnera, rising 600 feet above the plain, forms a conspicuous landmark in this sheet. An old Mahratta fort, built during the latter part of the 17th century on the summit of the hill, commanded the surrounding country. It was dismantled during the mutiny of 1857, and now a ruined wall is all that is left of its former grandeur; a fair is held annually in the early part of the year on the top of the hill, in honour of the temple situated on the northern brow. On the south bank of the mouth of the Auranga is a light on an iron lattice-work structure, built on a foundation of piles standing 50 feet above high-water. It is a simple parafine lantern, with two burners, visible nearly 9 miles out at sea. It is only exhibited from September to the end of May, as no boats venture to and from Bulsar during the monsoon.

An area of 155 square miles was surveyed in sheet 35, comprising 91 square miles British, and 64 square miles Baroda territory.

The area in the Dangs lies in the north-east quarter of sheet 49. It comprised portions of the Garvi, Dherbaoti, Palasvihir, and Amala Dangs and the whole of the Kirli and Shiobara Dangs. It is bounded on the east by the Pimpalner taluka of the Khandesh Collectorate, on the north by Baroda territory, and on the west by the area surveyed in season 1877-78. The plane-tablers began work just below the top of the Ghats where the forest was comparatively thin, surveying along the valley of the Dhodar River, one of the principal feeders of the Purna. The hills consist of low undulating spurs, with an average rise of 200 feet in a mile. After completing the eastern plane tables the parties moved west, where the forest is in excellent preservation. The work here lay in the valley of the Gira River. The hills here are more clearly defined, although the forest is heavy, and have an average rise of 450 feet in a mile. The highest hills are Hadol, 1,832, Mokhar 1,883, Dhep 2,556 and Kupi 1,866.

Three cart roads traverse the area surveyed, one from Songad along the north, *viâ* Malamdeo to Pimpalner, with a very gentle ascent up the Kondai Bari Ghat, another is from Bansda, *viâ* Garvi up the Haldunbari Ghat to Pimpalner; but this road is not much used, and is washed away in many places. The third branches off the second at Khambla, and crosses at the Jakràibàri Ghat, with a gradient of 1 in 50. The last road is the one more generally used in the timber traffic with the Deccan. Gram is largely cultivated during the cold months both below and above the Ghats. The staple food is Nágli or Nachni (*Clensine coracana*) and Wari or Sawa (*Paniceum miliacum*).

The inhabitants in these parts are credulous and superstitious in the extreme. About the end of January a fair is held at the peak forming the junction between the Nasik and Khandesh Collectorates and the Dangs. For a fortnight or three weeks before the time, the inhabitants of the surrounding villages take up in turn a cry to the gods to be propitious and clear the way. No one will venture up or near this hill before the day fixed by the Brahmins, certain death being the supposed penalty.

Mr. McA. Fee noticed that although the villagers suffered considerably from fever and diarrhœa, they were always ready with an antidote. He found on inquiry that an infusion of the bark Roin (*Soymida febrifuga*) was taken in half-ounce doses twice a day, which acted as a sudorific and sedative. The use of this bark is noted by Bently and Roxburgh.

Extract from the Narrative Report, dated 1st October, 1881, of MAJOR A. PULLAN, S.C., *Deputy Superintendent, Survey of India, in charge, Kattywar and Cutch Survey.*

The part of Cutch surveyed during the past field season comprised, firstly, a portion of the great "Rann" and the wide-spreading grass land known as "Bani," together with the low thickly wooded ground lying to the south and south-east of the town of Lakhpat (sheets 3, 4, 5, 10 and 11 of Cutch); secondly, a hilly country intersected by deep ravines and thickly wooded (sheets 13 and 14); and lastly, the open, well-cultivated ground near the seaboard, contained in sheet 16.

Principal Towns.

The principal towns contained in this season's work are Mandvi Bunder, a thriving seaport, second only to Bhuj in importance, with a population of 36,074 inhabitants; Gundiala, population 4,145; Nakhtrana Mota, an important town and Thana station, population 2,089; Godra, population 1,935; Asambia Mota, population 1,624, and Lakhpat, now falling to decay, but once an important place and port on the Khori River, present population 1,255.

Great Rann.

During the past field season, a part of the Great Rann, a wild and barren region of sandy waste and salt beds, which separates Cutch from the province of Sind, was surveyed on the scale of $\frac{1}{2}$ inch to a mile. But few roads cross this inhospitable tract, and these are open only during the cold and beginning of the hot season. Oozy salt slime and water is spread over the Rann in patches for the early part of the cold season, but as the warm weather approaches, the hot winds blaze across the salt waste like the breath of a furnace, and sand-storms sweep across the plain, rendering all communication between Cutch and Sind very hazardous. A more detailed account of the Rann by Mr. Fielding is attached.

Rivers and Ravines.

The rivers of the most importance passing through the season's work are the Kankawati, with a broad sandy bed in the cold season, dotted here and there with pools of brackish water; the Bhukhi, skirting the base of the hill of Dhinodhar, with its many feeders and rough cactuselad slopes; and the Bhurud, a river difficult to cross in many places, owing to its steep rocky banks, which have in many places a sheer fall of 70 feet. The two latter rivers empty themselves into the great Rann, and are lost in the salt sands, while the first named river empties itself into the Gulf of Cutch, near the village of Chhachi.

Hills.

The most important hills are Dhinodhar, Vethon and Lakhria. Of these the most remarkable is the horse-shoe-shaped Dhinodhar, the second highest hill in Cutch, having an altitude of 1,268 feet above mean sea-level, and rising about 1,000 feet abruptly from the plain. Dhinodhar is topped by temples, held sacred by both Hindus and Mahomedans alike; and twice in the year a feast is held, in which both castes partake. Dhinodhar is very steep, and covered with dense "Kheir" jungle. The temples on the summit are accessible only from Aral on the west, or from the large temples (Than) on the east base of the mountain through the horse-shoe valley. The next in height is Lakhria, 1,184, and Vethon, 916 feet above sea level; both very steep cones, rising abruptly 800 and 600 feet above the plain.

Climate.

The climate of Cutch during the months of December, January, and February, though occasionally hot, is on the whole very pleasant, but March and April in all the inland part of the country, which is away from the coast and its temperate sea breezes, are very hot and trying. The thermometer frequently rises to 110° in the tent, and the hot winds are like the breath of a furnace. Just before the westerly breeze, fore-runner of the monsoon, sets in, the nights are very oppressive, the thermometer frequently registering from 90° to 95° at 10 P.M.

Addenda from a Report by Mr. FIELDING.

The villages in sheet 5 are few, and owing to the famine were nearly all deserted. Provisions were scarce and dear, water brackish and bad; in fact at many villages the water positively tank.

The only place of importance in this sheet is the town of Lakhpat, which, with its high walls, looks from a distance very imposing, but a nearer view disenchants one. About half the houses are deserted and in ruins, and every thing presents an appearance of great poverty.

There are here a Thanadar's and a Fouzdar's Courts, with a prison and a considerable body of Police. In days long gone by, Lakhpat was a Bunder of some importance, and as its name signifies, its trade (import and export) amounted to a lakh or lac of khories a day. A raised causeway led from the north gate to the old bank of the creek, which is now, owing to tidal changes, a couple of miles away. Its glory has utterly departed, and but few boats now find their way up as far as Lakhpat. The passage of pilgrims across the Khori Creek, at 7 annas a head, is about the most important item in the revenue of this decayed town. Before the earthquake of 1819 there was water communication between Lakhpat and Raham-ki-Bazar in Sind by means of the most eastern branch of the River Indus.

The Khori Creek, which runs diagonally through sheet 5, though now an arm of the sea, was before the great earthquake a sweet-water canal filled by the water of the Indus, which is even now talked of as the "Mita Dariya" or sweet sea. Since the earthquake, the Khori has been gradually silting up; new mud banks of considerable size have formed even within the past fifteen years, during which time the ferry route has been twice altered, and the old course of the stream where it enters sheet 5 is now only defined by a narrow strip of water having a depth of but a few inches.

Previous to the earthquake the Khori was navigable for small boats as far as *Sindri*, the Cutch Frontier Custom station (all vestige of which has now disappeared; even the name has been lost to all save a few old men), and from Sindri it was navigable for flat-bottomed boats for many miles into the province of Sind. A considerable amount of traffic was carried on by this water-way. Ghee, rice, and bajri being the chief articles conveyed: these are now carried by camels across the Rann. In past times Basta Bunder, on the north bank of the Khori Creek, was a place of some importance as a port, and carried on a large trade with the Malabar Coast, Zanzibar and the Persian Gulf. Basta Bunder was a town of considerable size, chiefly inhabited by Banias, and though now lying in the midst of an extensive salt waste, was,

at the time of its existence, surrounded by rice fields and trees, and had many wells of good water.

Sheets 3, 4, 10, and 11 embrace a part of the Great Rann, which, with the Allah Bund, or "Dyke of God," is probably a tract of country without parallel in the whole world. The Rann, which in the dry season is a sandy desert without a scrap of vegetation, with here and there dangerous bogs and extensive tracts of salt, is, during the south-west monsoon, an immense shallow inland sea. It is crossed by but few roads, and travelling over the Rann in the hot weather, save by night, is rendered a matter of extreme difficulty and even danger. The hot winds blaze across the Rann like the blast from a furnace, while the clouds of dust render it impossible to advance; carts are but little used, owing to the impossibility of procuring water for the cattle; travellers carry sufficient water for themselves in leather bags, or "Sandharas." The whole length of the road in the Rann is marked out by the bones of cattle and camels which have died from exhaustion and thirst. A heavy shower of rain closes the road for days, and camels caught in heavy rain in the Rann have little chance of escape. Last April the tail end of a cyclone passed over the Rann, causing the death of over a thousand camels and cattle. Before the earthquake of 1819, the river passing through these sheets might have been seen dotted over with small boats carrying the produce of Sindh down to Lakhpat, where it was transhipped into larger vessels and thence carried to distant ports. The great earthquake, however, closed the river and destroyed several villages, most of the inhabitants being buried in the ruins. The Cutch custom station called Sindri was destroyed at this time. Prior to the earthquake the very considerable extent of country lying between Raham-ki-Bazar and Allah Bund, was covered with rice-fields watered by the Indus, and the remains of an old canal crossing the road leading from Luna in Cutch to Raham-ki-Bazar in Sind bear silent witness to bygone irrigation. The extent of the ruins of Kanjorkot and Wogo-ja-kot plainly show that they must have been towns of considerable size. The whole of this strip of land is now a salt waste, producing a coarse grass on which the cattle and camels of Sind graze.

Tradition states that prior to the great earthquake of 1819 the Bani of Cutch extended as far as the Allah Bund, and the presence in the Rann of innumerable stumps of trees, sometimes found singly and sometimes in clumps of a dozen and more, proves, I think, that the character of the Rann was in bygone days very different to what it is now. I was informed that what is now Rann was at one time an immense tract of pasture land similar to the Bani, covered with hamlets or Wandhs, and that innumerable herds of cattle were to be found covering the whole land, and that wells of fairly good water were to be met with.

A fact worth noticing in connection with the Great Rann is the presence of salt varying from 2 to 12 inches in thickness and covering many miles of country. This salt is exactly similar to that of Patri, being of pure white crystals, very hard and pungent in flavour.

The mirage is never seen to greater advantage than on the Rann: small objects are so magnified and distorted as to be unrecognisable; for instance, a *koojah*, or water-vessel, at a distance of nearly a mile appeared like a tree of 10 or 15 feet in height, and a Chinkara deer looked like a tall two-masted ship. The Rann is the habitat of the wild ass, which on a bright hot day assumes the proportions of an elephant.

General description by MAJOR H. LEES SMITH, *Assistant Superintendent, 1st Grade, of the country surveyed by No. 10 Party, Revenue Branch, in season 1880-81.*

Towards the south of the tract brought under survey last season,—where the line of the ghâts approaches the coast, which in some cases is only 20 miles off—the country is rugged, and broken into high hill ranges and narrow valleys. The most important of these is the valley of the Amba River, which river rises immediately under Khandala, on the Bhor Ghât, and flows in a south-westerly direction for about 20 miles through the "Pant Sachew," or Bhor State, forming a picturesque valley, with the great mass of the ghâts on the left, and a high range of hills on the right.

There is a remarkable hot spring at the village of Unhera Khurd in this valley, close to the conspicuous rock crowned by the Sarasgad Fort, which towers over the village of Palee. The Amba River, here turning to the north-west, passes the bridge and town of Nagotna. Thus far it is a fresh-water stream. It here meets the tide, and its entire character changes.

Nothing is more striking to a new comer than the difference in the rivers of the Konkan before and after their waters unite with those of the sea. This is more remarkable when, as is usually the case, the tide comes up along the river-bed into the heart of the district. After riding, it may be for miles, along the banks of a rocky stream, with grassy banks and deep clear pools of cool water, with all the varying charms of Indian river scenery, the picture suddenly changes to black mud and dirty water, confined by rude clay dykes, with nothing but a few stunted bushes here and there to vary the monotony of the landscape. In many cases the very name of the river is changed, the fresh water portion being known by one name, and the tidal portion by another.

Nagotna is an important town, with a pier, or "Bunder," travellers' bungalow, civil bungalow, customs office, and post office, &c. It is the point of disembarkation for travellers to Mahableshwar. A large trade in wood is carried on with Bombay.

The Amba River, which from this point is also known as the Dharmtar creek, continues for 20 miles from Nagotna to Rewas, on the south of the Bombay harbour, where it expands into a broad channel.

About 12 miles from Nagotna is the port of Dharmtar, where there is a post office and jetty. A steamer runs between Bombay and Dharmtar daily, calling at Rewas.

The Kundalika River, which for a short distance from the sea, divides the native state of Habsan from the Colaba district, is a very large tidal creek, running along the south of the Alibag taluka of the Colaba district.

Revdanda, at the entrance of the Kundalika River, is a large town, with a port, customs office, post office, and a very extensive fort, in which are numerous remains of chapels and towers of a very ancient date. The mail steamer from Bombay calls here daily during the fair weather.

Alibag is situated north of Revdanda on the sea coast. It is the head-quarters of the Colaba district, with a sea customs office, post office, civil bungalows, &c. A large fort in good preservation is situated on a rocky island a short distance from the shore. The mail steamer calls here daily in the fair weather. The fort of Sagargad, on the summit of the hill of that name, 1,356 feet above the sea, is situated about 6 miles to the east of Alibag. There are a couple of bungalows on the hill. Seaward and to the north, the island of Khanderi, with its light-house and fort, forms a conspicuous object.

A few miles further north, the harbour of Bombay commences. The scenery round the shores is picturesque in the extreme. The high hills of Dronagiri or Karinja, Trombay, &c., towering above dense groves of palms, cocoanuts, and other trees at their bases, and set in a bright fringe of evergreen mangroves, which appear at high tide to grow out of the sea; in the distance beyond, the shipping, the city with its handsome buildings, towers, and minarets,—all form a picture not easily forgotten.

At Uran, an island on the eastern shore, there is a civil bungalow, post office, customs office, and pier, and a large distillery. Elephanta island, or Gharapuri, situated in the centre of the harbour, is celebrated for its rock-cut caves. Close by is Butcher Island, on which there is a battery; and nearer the shore are Cross Island and Oyster Rock batteries. Immediately to the east of Elephanta, and separated from it by a very deep channel, is Hog Island, situated at the entrance of the Panwel river, on which an hydraulic lift was erected in 1872 at a cost of £350,000. It has never been used. Towards the north, the harbour narrows into the Thana creek, which separates the island of Salsette from the main land.

About 3 miles north of Thana, the Ulas river joins the Thana creek; and here a curious effect is noticed, caused by the meeting of the two semi-diurnal tides, one running from the harbour on the south, and the other from the sea (near Bassein) on the north, which produces an ebb and flow in opposite directions, and at this point leaves a certain portion of the water of the creek more or less unaffected by the tidal influence.

The Ulas is the most important river in this part of the district. It rises beneath Khandala, on the north side of the Bhor Ghât. On the south, and a few miles away, the Amba River, above noticed, rises. These two streams conduct most of the drainage of this part of the country from the ghâts to the sea. The Ulas River is navigable up to a short distance beyond the town of Kalyan, on the Great Indian Peninsula Railway.

The Thana creek is crossed by a handsome iron bridge and by the Great Indian Peninsula Railway bridge at Thana, and again by the Bombay, Baroda, and Central India Railway bridge near Bassein.

The only other important river in these parts is the Patalganga, which rises from the same place as the Amba and Ulas rivers, namely, the crest of the Bhor Ghât near Khandala, so that this one spot is the starting point for the whole of the drainage of these districts from the ghâts to the sea. The Patalganga is the name of the fresh-water portion of the stream. Towards the coast it is called the Megowin creek. It is navigable for about 14 miles from its mouth at the south-east corner of the Bombay harbour.

The principal towns surveyed last season in the Thana district are Thana, Bandra, Panwel, Karjat, Kalyan, Morebad, and Matheran.

Thana, a seaport town on the Great Indian Peninsula Railway, is the head-quarters of the district. It contains Judge's and Assistant Judge's courts, a high school, a church, a Roman Catholic chapel, a very large jail, a post office, &c. Two companies of a native regiment garrison the place. The jail is situated in an old Portuguese fort of great strength and in good preservation. Excellent carpets, cane work, cloths, and carpenter's work are the principal industries carried on at the jail. The population of Thana is about 13,000, chiefly Indo-Portugese and Native Christians. A brisk trade in silk is carried on. The town is supplied with water from the Pokran reservoir about 3 miles away.

Bandra, on the Bombay, Baroda, and Central India Railway, is a suburb of Bombay with a population of about 9,000; there are handsome Roman Catholic chapels, orphanages, &c.

Panwel is a flourishing port of about 8,000 inhabitants, situated on the Kalundri River, near the eastern shore of the Bombay harbour. It has a sea customs office and salt store, post office, travellers' bungalow, &c. The ferry steamer from Bombay calls daily at Ulva Bunder about 5 miles away.

Karjat is a town on the Great Indian Peninsula Railway, at which the ascent of the Bhor Ghât commences. It is the junction for the short alternative Railway line to Kampali, under the Bhor Ghât.

Kalyan is a port on the Ulas River, with about 14,000 inhabitants. It is an important Railway station, being the junction of the north-east and south-east lines of the Great Indian Peninsula Railway. It was a very flourishing sea-port in old days.

Matheran is a well-known hill sanitarium, about 7 miles south-west of Narel, a station on the Great Indian Peninsula Railway. It is about 2,500 feet above the sea.

Morebad, with about 1,000 inhabitants, is the head-quarters of the taluka of that name.

Kurla, 2,500 inhabitants, and *Bhandup* 1,000 inhabitants, are situated on the Great Indian Peninsula Railway, and are suburbs of Bombay.

In the Kolaba district the chief towns are Alibag, Nagotna, Pen, and Revdanda. Alibag, Nagotna, and Revdanda have been already described. Pen, with about 6,000 inhabitants, is situated about 5 miles from Dharmtar, on the eastern side of the Amba creek.

Extract from the Narrative Report of MAJOR R. BEAVAN, *in charge, Beluchistan Survey Party,— Season 1881-82.*

In the last Annual Report submitted, the state of the survey work up to the end of September 1880 was reported upon. It is, therefore, necessary now to refer to the work executed between the 1st October 1880 and the 30th September 1881, although these dates do not coincide with the completion of the season's field work in Beluchistan.

In fact, it is difficult in these parts to arrange a definite period for field work in distinction to recess work, as the intense heat renders tent life in the lower country impossible between March and November, while, on the other hand, the intense cold prevents survey work being carried on from November to March in the higher country between Quetta and Khelat.

It is moreover difficult even in these elevated tracts to survey accurately or rapidly during the hot months of June, July, and August, on account of the thick muddy state of the atmosphere during the greater portion of the time.

This phenomenon is peculiar; sometimes it increases gradually day by day, sometimes it commences suddenly; one day may be clear, and the next day everything beyond a few miles distance may be hidden by a veil of mist or fog. Dry mist it might be called if such a thing were possible, but it does not appear to be due altogether to the presence of dust in the atmosphere. Such near hills as may be visible are hazy and indistinct, and the spurs and other minor features are indistinguishable. This state of things may last for weeks together, and at such times triangulation becomes quite impossible, and topography difficult and uncertain.

The general effect, therefore, of the climate of Beluchistan is to make, for the elevated tracts, the four months, April, May, September, and October the most favourable for survey work, and for the lower country the four months, November, December, January, and February, are the best.

It is not, however, practicable on every occasion to confine the field work to the seasons best suited for it; and in the year under review the months of February and March only were given up entirely to recess work, the remaining ten months of the year being devoted principally to field work in various directions.

Strength of party.

The effective strength of the party has remained nearly the same throughout the year. It was as follows in September 1880:—

1 Assistant Superintendent in charge.
2 Assistant Surveyors.
1 Office Writer.
3 Sub-Surveyors.
40 Klassies and Tindals, including 1 Duftry.

Work performed by the members of the party. Major Beavan.

I left Quetta on the 26th September 1880, visiting Mr. Coxen and Barkat Ali *en route*, and marched down the Bolan to Sibi. I had previously seen Lieutenant-Colonel Chapman, Chief of the Staff to Sir Frederick Roberts, and obtained permission to join the expedition that was starting for the Marri country under Brigadier-General Macgregor.

I joined the force at Sibi, which we left on the 12th October. We marched first to the Mandai Valley, which we found deserted by its inhabitants; halted here two days. We then went up the bed of the Dadar River, between high cliffs, to Dalugal, on the line of the proposed railway. Thence we marched by the old route *vid* Spin Tangi and the Sembar Pass to Thal. This part of the route I had surveyed the year previous.

From Thal the force marched due east to Baladag, thus skirting the Marri country, which lay south of our route, but entirely hidden from our view by a series of parallel ranges of hills (of which Tikhel 6,600 feet, is the highest point), beyond and beneath which, lies the plateau of Kolu. At this point we were close to the camping ground called in Captain Hol-

dich's map Baladaka, but the place itself was not recognised, and I believe our path took us a mile or so south of the old encamping ground.

We did not stop here, but encamped at Gusra, 3 or 4 miles further on. We thus turned the end of one of the main ranges referred to above, and crossed over the other range by the Kuba Wanga Pass, finding ourselves at the upper extremity of the Kolu Valley, down which we marched in a south-westerly direction towards the Dowla Wanga Pass.

The Kolu plateau terminates abruptly towards the south in a line of steep cliffs, beneath which our line of march continued so far as Kui, and thence, breaking through several small parallel ranges and following the Maugra stream, we arrived at the Fort of Mamand, which also we found deserted.

From Mamand to Kahan the road wriggles its way along the course of streams, between high cliffs, and among broken and rugged hills, of no great height but hopelessly involved and intricate. Marching continuously day by day, and unable to leave the line of route sufficiently far to ascend any commanding hill from which a view of distant known peaks might have been obtained, I found it impossible to fix my positions any longer by intersection. I had therefore to be contented with entering the route as near as I could from the general direction and approximate distances from camp to camp. On emerging from between the overhanging cliffs into the open valley of Kahan, I found no single hill or point visible, of which the position was known to me.

At Kahan itself (where we made one day's halt) I observed with a small theodolite for latitude and time. The latitude observations were good, but I was not able to get a satisfactory value of longitude, as the rate of my watch, I found out afterwards on working out the observations, had altered between the time of leaving Sibi and that of arrival at Drigri Fort in the Derajat, so that I was unable to get the proper correction to be applied to the watch time for the interval between leaving Kahan and arriving at Drigri.

The first place after Kahan, where I was again able to fix my position on the plane table, was at the Burzen Pass, where Gandahari Hill and Jandran Peak came into view.

The position, therefore, of Kahan Fort had to be deduced from the following data :—

1st.—The position as given on the old maps with reference to Sangsila. This appears to be very nearly accurate, as it agrees well with the other results.

2nd.—The latitude, by observation of Polaris.

3rd.—The position deduced by dead reckoning, and corrected afterwards by the fixing of Tatra Hill by theodolite intersection.

4th.—An independent value of the position of Kahan was obtained from the road traverses, carried through by Captain W. Gill, R.E., who accompanied the force. This officer prepared an elaborate report on the road traversed by the expedition, and made a sketch in illustration, on the scale of 1 inch to the mile, showing, in detail, all the turnings and difficulties of the road. He paced the distances and took compass bearings all through, plotting as he went along. By comparing the direct distances from camp to camp, in such portions of the route as I had them fixed accurately, the average value of Captain Gill's paced distances was deduced, and by then reducing his work to the same scale as mine and joining up the sheets, a fairly good position could be obtained for Kahan by interpolation.

The general result, as entered on the published map, is, I think, correct in latitude, and liable to an error of perhaps a mile either way in longitude.

Leaving Kahan and marching eastwards we arrived at the outpost of Drigri on the 14th November, I then returned to Sibi *viâ* Khanpur and Sukkur.

During the following month negociations were being carried on with the Marris, and the road up the Nari River remained closed. It was not re-opened till the 24th December, when I started to continue the triangulation and the topography of the Marri Hills from the Sibi side, and continued at this work till the end of January.

During February and March we were in recess at Sukkur, in accordance with instructions received from the Surveyor General, completing the computations and fair mapping.

In April the party moved to Quetta, where the office remained in camp during the summer. During these months I took advantage of such opportunities as occurred for completing unfinished portions of the $\frac{1}{2}$-inch survey of the Pathan country east of Quetta. In June I accompanied Lieutenant-Colonel St. John, R.E., Agent, Governor General, to the valley of Kawas, and succeeded in sketching in a very interesting piece of country lying to the north of Khalifat Peak, as far as the watershed of Ziarat.

In September I arranged, with Colonel St. John's assistance, to ascend the mountain known as Zarghun, lying east of Quetta. The chief of the Dumar Pathans was sent for, and agreed to take me to the summit of the hill with a party of his own men, by which means I was enabled to sketch in a tract of country hitherto unexplored.

In July, and again in August, I visited the parties working near Mastuug and Mungchar, and attempted to extend the triangulation in the direction of Shorawak, but was unable to make progress with this work, by reason of the thick mist or haze referred to above. In the intervals, my time has been fully employed with the routine work of the office.

Remarks on the country under survey.

The survey work executed by this party is of two kinds, corresponding to the natural divisions of the country : 1st, a geographical reconnaissance, on the scale of 1 inch=4 miles, of

Sewestan and the Marri Hills; 2nd, a more elaborate survey, on the scale of 1 inch=2 miles, of the territories subject to the Khan of Khelat.

The name Sewestan, I am informed, formerly included a large tract of country, much of what is now in possession of the Marris, and of the Katch Gandava Plain even as far as Jacobabad and Shikarpore. The Pathan have however been forced back by the encroachment of the Biluch tribes, till now Sibi, the capital of the old province, and from which it takes its name, is actually isolated from the remaining portions of its former territory.

At the present time Sewestan may be defined in a geographical sense to include all the district drained by the Nari River and its affluents. This certainly includes portions of the Marri country, but there is no natural line of demarkation between the tracts now held by the Marris and by the Pathans, from whom the former have won much land by forcible encroachment.

The tract is essentially one of rugged, broken ranges of hills, varying in height from 10 feet to 10,000; sandstone mostly near the plains, changing into limestone formations further back, and running in a general east and west direction.

The limestone hills are noticeable for their rounded formation, the strata being bowed or bent across the axis of eruption, as if they had been elevated in a plastic condition.

Huge cracks, or crevices, have been formed across, and at right angles to the line of hills (due perhaps to shrinkage on drying, as may be observed in sun-dried bricks), and through these the drainage of the country makes its way. Hence is presented the anomalous condition of parallel valleys, with rivers running at right angels to them.

The sandstone formations also lie in parallel ridges, the strata being greatly inclined, but not bent over. In this case the face of each successive outcrop forms a cliff, and in many parts the rocks lie broken and mixed up in magnificent confusion. Dry, barren, and desolate, the aspect is that of a heap of broken bricks on a magnified scale. The ancient legend, which asserts that after the creation of the world the spare rubbish was shot down here, does not appear altogether unreasonable. It is impossible to give an adequate idea on the map of such a country.

The general elevation of the ground increases as one proceeds northwards, till, above the Harnai Valley, it rises very suddenly, and culminates in the peaks of Nishpa, Kasa, Khalifat, Zarghun, and Takatu, at heights of from 10,600 to 11,700 feet.

The grandest of these in appearance is Khalifat, which rises abruptly above Sharigh for 7,000 feet.

Behind Khalifat lies Kushnob, an open flat-topped hill, 6 miles broad by 10 miles in length; height 10,000 feet. This is covered with juniper forest, and grass is plentiful, but there is a scarcity of water. Between Kushnob and Pil Mountain is a tremendous rift, through which the Kawas Stream makes its way. Below is the Chapar Rift, through which a good road has now been made, and where the line was laid out for the proposed railway to Kandahar.

The Zarghun Mountain is the highest in Southern Afghanistan, the culminating point being 11,730 feet above sea level. It is also one of the largest in area, occupying a considerable tract of land. The summit forms a rude circle of 6 miles diameter. It is composed entirely of conglomerate rock, formed of rounded water-worn pebbles firmly cemented together.

The strata dip from all sides inwards towards the centre, presenting outwardly a sheer precipice in every direction. It gives one the idea that the whole mountain must have been elevated in the form of a bubble, and afterwards settled in the centre, leaving the circumference standing upright. The drainage escapes into the Hanna Valley through a series of gorges. The higher parts of the hill form grazing grounds for the flocks of the Dumar Pathans during the hot months. There is abundance of excellent water, and a large supply of wood (juniper).

The upper portions of the hill slope gently inwards, but are cracked and divided by the most frightful chasms and precipices that it is possible to conceive. No description could give an idea of the place, but it would not be inaptly represented by some of Gustave Dore's illustrations to the *Inferno*.

The survey of the tracts above described is being carried out on the scale of 1 inch = 4 miles. A large portion of it has been already sketched, and is shown on the published maps; but some still remains to be done in the more inaccessible tracts. The Pathan tribes being of a treacherous disposition, and having no scrupulous regard for human life, exploring parties are not permitted to move about this part of the country without strong escort, and troops are not always available for this purpose.

A more systematic and elaborate survey, on the scale of 1 inch = 2 miles, is being carried on over the country subject to the Khan of Khelat, which lies to the west and south of a line joining Sibi and Quetta and includes the Bolan Pass.

This tract consists chiefly of a series of elevated plains, separated by mountain ranges. Wherever water is obtainable for irrigation these plains are cultivated and fertile. In other parts they are barren and desolate, affording only scanty nourishment for droves of sheep and goats. The general level of the plains between Quetta and Khelat is from 5,000 to 6,500 feet. Above these the mountains rise in bold masses to a further height of 5,000 or 6,000 feet.

The principal hills are Murdar, Nodgwar, Chihaltan, and Koh-i-Maran, of which Chihaltan (10,860 feet) is the highest. The Bolan Pass is well known, and forms the only

direct line of communication between the elevated country and the plains of Sibi suited to general traffic.

Brief Geographical and Statistical Sketch of the Angyee Township, Hanthawaddy District. By MAJOR J. E. SANDEMAN, *Deputy Superintendent, 3rd Grade.*

The Angyee township, together with the Syriam township which was described last year, forms the southern division of the Hanthawaddy District, under an Assistant Commissioner. It is situated approximately between the parallels of $\frac{16°16'}{16°53'}$ north latitude, and the meridians of $\frac{95°53'}{96°23'}$ east longitude. It is bounded on the north by Rangoon town, the Pan-hlaing River, and Rangoon River; on the east, by Rangoon River, and Gulf of Martaban; on the south by the To or China Bakeer River; and on the west by the To and by the Khateia Yea Gyaw, the last is a narrow creek connecting the Pan-hlaing with the China Bakeer.

The township is divided into the following circles:—

On the north are—Pan-hlaing, Ma-hlaing, Tamatakaw, Khanoungto.
On the east—Pyawbweh, Kodoung, Moke-yoon.
On the south—Ze-pathway, Tawkoo, Lawadee.
On the west—Engdapooya, Twantay.
The central circles are—Kawhmoo, Tan-ma-naing.

The correct areas of these circles cannot at present be given. The approximate area of the township is 850 square miles.

Pan-hlaing Circle.—The eastern portion is fairly well cultivated; towards the south, near the village of Zeegyone, is a small extent of high ground wooded and covered with bamboo, mangoe, and plantain gardens. The western and north-western portion is much flooded and covered with *kcing* grass, gardens being scattered along the bank of the Geagyaw only. To the extreme south-west is an island belonging to the circle formed by two channels of the China Bakeer River. It is wooded, and is fringed with gardens.

Ma-hlaing, Tamatakaw and Khanoungto, Pyawbweh and Kodoung circles form one paddy plain with a little jungle on the Bassein creek.

Moke-yoon Circle is chiefly cultivated, but there is a good deal of jungle in the following kwins:—Aloonzoke, Thootay, Kweh-bweh, Kalonkta, and Saybyoung.

Ze-pathway Circle is all cultivation, except along the Bassein creek and sea-coast. The following kwins are all jungle:—Tankay, Tankazaw, Wehbalain, Wehma, and portion of Ghuet-oo.

Tawkoo Circle.—This is a paddy plain with some jungle on the Bassein creek. The following kwins are all jungle:—Kabalan, Hta-pya-tan, Kyoo-gya-tan. No. 25, a Grant kwin, has scattered cultivation among the jungle.

Lawadee Circle is one-half rising ground consisting of forest with scattered gardens; at the foot of the high land are swamps, with rice fields in hollows, and on the banks of the rivers at Tawkyawgalay are gardens. The following kwins consist chiefly of gardens:—Dakoochan, Myogone, Thit Kyagone, Myoung Ngoo, Inpatee, Myay Neegone. All the open part of the circle is rice land, the fields being very small, the smallest in Sake Kalay.

Engdapooya Circle consists in part of a mass of rice land, the fields towards the east of the cultivation being very small. The eastern portion of the circle is high land, and the forest is full of gardens, especially in the following kwins:—Tike-gyee E, Taloke-Tan, Pyee-Rado and Myoung-gon.

Twantay Circle consists in its eastern half of high land covered with forest, where there is not forest it is a mass of gardens; the western portion is a vast swamp. In the kwins along the China Bakeer is some rice cultivation, as also a little in those to the north near Twantay. No. 34 kwin is a very large waste land grant. In this circle are the remains of the palace of the Talaing Kings, of the orchards of the royal fruit, "the Sapodilla plum," and of an ancient city.

Kawhmoo Circle is a vast paddy plain on the east, and high land on the west. The fields are small and irregular, and the paddy clearings run into the forest, which, towards its edges, is a mass of gardens.

The Tan-ma-naing Circle is a paddy plain with here and there many salt pans. On the east, along the bank of the Bassein creek, is a belt of jungle, in some places a mile wide.

Speaking generally, the township in its eastern half is a vast alluvial paddy plain, the soil in parts being very suitable for the growth of paddy, and in parts, swampy. There are narrow stretches of mangrove and jungle along Bassein creek and the sea-coast, elsewhere the plain is almost treeless. The western half of the township is undulating land, covered with forest, and is called the "Tan-gyee," or great forest, by the Burmese. Its northern limit is marked by the Golden Pagoda at Twantay which, as it glitters in the sun, is a landmark for many miles around. At the foot of the eastern and northern slopes of this highland are swamps which continue along the western half of the Pan-hlaing Circle. The soil is an alluvial clay and very good in places, especially in the north-east and centres of the township. In the description of each circle it has been mentioned where the fields are small; in the other circles they are pretty large and regular. The amount of rice cultivation, and of gardens, also the amount of culturable and unculturable land, &c., cannot be given until the settlement is completed, and until the survey areas are divided under their proper headings.

The revenue is as yet collected in the old way on measurements made by Thoogyees. The total revenue collection is as follows :—

	Rs.
On Paddy land	4,75,812
Cess	47,480
Garden land	24,096
Cess	2,407
Capitation Tax	1,02,505

During the past season the settlement operations have embraced 4 circles :—Khanoungto, Tamatakaw, Pyawbweh, Kodoung; but the revised rates will not come into operation for eighteen months, in order that the cultivator may have plenty of notice of the raising of his rates.

In this township the soil has been classified into two kinds instead of into four, as in Syriam. It was found that the latter minute classification complicated operations too much.

In the circles in which the local "revenue settlement" survey operated some years ago, the rates will not be much raised by the present survey, as then there was a large increase; but in all the others it is likely that the same high rate of increase of revenue to Government will result as has been the case in Syriam. The fact is that cultivators hold a large percentage of their lands rent-free. This will be evident when I mention that in the whole township only 174,809 acres of paddy and 9,200 acres of garden cultivation are assessed; the estimated area of the township being 840 square miles or 537,600 acres.

This is essentially a paddy-growing township. "Paddy," or unhusked rice, is therefore the principal product. Some of its varieties were given in the report on Syriam. The gardens on the highland, produce mangoe, plaintain, betel-nut, mayans (an acid plum), pawn, and some wild fruits. Mangoes and plantains are in great abundance although there are no good kinds of either. The Sapodilla plum, of which there are four trees only left in a garden kwin Lekhonkon in Twantay Circle, was the only royal fruit of the Talaing Kings. Each of these trees has a masonry platform round it. Pawn gardens are numerous; the village of Koon-gyan is surrounded with them. There are gardens of the "danee" palm along the creeks and rivers, these palm leaves being much used for thatching. There are also tracts of "Thekkeh," or thatching grass. The *keing* grass furnishes reeds from which mats are made. The Shans near Twantay cultivate vegetables.

The manufactures are few. Salt is manufactured at Tan-ma-naing and a few other villages. Ironware, chiefly "dahs," are made at the villages of Oophoo and Ynathit in the Pan-hlaing Circle; there are as many as 30 ironsmiths engaged in the manufacture. Oil is pressed here also, the seed being got from Rangoon; and mats are made in large quantities of the *keing* reeds with which the Pan-hlaing circle is covered. At Koongyan, the hats which Burmans use in the rains, made of bamboo and leaves, are manufactured in numbers. At Kyiektan "danee" roofing is made and sent to Rangoon for sale. But the manufacture for which the township is famous is that of glazed pots, which are purchasable at Twantay, and to a smaller extent at Kyon-Kyan-gon. At the latter place they are made for salt boiling, and more sand is used in their manufacture. At Twantay the ordinary alluvial clay is dug out of pits close by; the glazing is done with a mixture of galena and rice water. A great quantity of "Nga-pee," or fish paste, is made at Twantay, which is the market for the fisheries close by in the Pan-hlaing Circle.

The forest trees are mangrove and willow, found on the banks of creeks; and on the highland, there are bamboos in variety, mangoe trees, Pyeng-ma (*Lagerstromia reginae*), Eng (*Dipterocarpus tuberenlatus*), Pyengado, Mayan, and Kaneraf. There are deer in the forest, but they are scarce. Jungle fowl are plentiful, but there is no other game except an occasional leopard. In the swamps near Twantay, ducks and snipe are found in the season.

The Irrawaddy inundations, which have flooded much of the country further north owing to the embankments at Henzada, are also felt in the western circles of this township, especially in Pan-hlaing, and it seems likely that cultivation will diminish in that circle.

There are 48 fisheries in the township, chiefly confined to the flooded Pan-hlaing Circle. The following list shows the revenue derived from each by Government :—

	No.	Revenue. Rs.
In Twantay Circle	2	2,645
Engdapooya ,,	2	430
Kaw-hmoo ,,	3	2,005
Moke-yoon ,,	1	100
Pan-hlaing ,,	39	32,811
Mahlaing ,,	1	2,600
Total	48	40,591

If some of these were abolished it might tend to increase cultivation.

Twantay is the chief place in the township. It is a long village, prettily situated at the foot of the "Konedan" and on the left bank of the Twantay creek. It has a wooden court-

house and a police station on a height above it, but the houses of the inhabitants are poor for a place of its size. The road through the village is of bricks on edge. There is a bazaar, but it is a shabby building, and I understand that a new bazaar is to be built. At Twantay the Extra Assistant Commissioner lives, and the Assistant Commissioner and District Superintendent of Police frequently visit it. It is a place the trade of which is likely to increase. There is a large produce from its gardens; it is the seat of the fish paste manufacture, and it is famous for its pottery.

The other principal villages are:—Pyawbweh, Khanoungto, Thamaning, Tawkoo, Tankyan, Kyon-Kyan-gon, Engalon, Kyektan, Kambay, Kanyengon, Thongwa, Oophoo and Nathit, Let Kheik, Kannoo, Shanzooyea. Near Kyektan there are some fine zaiats and kyoungs. Kyon-Kyan-gon has some fine zaiats. Many of the villages have the principal houses built of wood. Most of the other houses have mat walls; and at the commencement of the rainy season, these are renewed as well as the thatch of all the houses. When this has been newly done the villages look very smart.

There are no rivers which flow through the township. The Rangoon River forms its eastern boundary, and the China Bakeer its southern and part of its western boundary. The Rangoon River is well known, as by it ships reach Rangoon.

The To or China Bakeer is reached from the Rangoon River by the Bassein creek. There is a bar across its mouth which prevents ships entering it direct from the sea. There are a number of forest-clad islands in its course.

The Pan-hlaing creek borders the township on the north; it joins the Rangoon River just above Rangoon. It is the passage in the rains for river steamers going up to the Irrawaddy, and is navigable for large boats at all times. The Bassein or Thakwotpang creek is by far the largest in the township; it connects the Rangoon and China Bakeer Rivers, and is the course for river steamers to Mandalay and elsewhere for most part of the year. In this creek there is a bore formed by the meeting of the tides from both its ends. It is therefore at times dangerous for small boats. The Bassein creek cuts off the two circles of Moke-yoon and Zepathway from the rest of the township. There is one island in it and a number of shoals over which steamers cannot go at low water.

The next in size to the Bassein creek is the Khanoungto and Twantay creek; it is the highway for boats from Rangoon to Thongwa. Unfortunately it has silted up so much for some miles, near Kamleng, where the two tides meet, that there is not always a passage through it, and it can only be used at spring tides. This route is of such importance for boats coming to Rangoon from the Irrawaddy, saving them two or three days' journey, that it would be a great matter could the channel be dredged where it has silted up; or the creek might be made into a canal, being locked at both ends; but this would be a vast engineering project. I have heard that the Chief Commissioner contemplates improving this important highway. There is no doubt Burmans would gladly pay toll were a canal made. This direct route to the Rangoon market would open out the Thongwa District. There are no other important creeks in this township. There is a small one through the Pan-hlaing Circle, another connects Pyawbweh with the Rangoon River, and there are many minor creeks.

The only made road is one from Dala opposite Rangoon to Twantay. A road is to be made from Dala to Pyawbweh; another from Thongwa in the Lawadee Circle *viâ* Kannoo to Kamleng; another from Kyektan on the China Bakeer through Kannoo and Tan-ma-naing'to Wahbabouk-thouk; another from Nyoung Kyoung on the Rangoon River to Pyawbweh. These roads will no doubt open out the township to a certain extent, but Burmans will not use a road when they can, even by making a circuit, reach the place by water.

The highland is intersected with good roads which require no making, the soil being so dry. There is a fair-weather road at the foot of the Angyee Konedan from Kamleng to Engalon; on the one hand is a dense forest, and on the other a treeless plain, the Burman homesteads stretching continuously along this road for miles.

There are not many antiquities in the township. At Kyoungyaw and Twantay we traced up the walls of a city and of an inner citadel or fort. These walls are of enormous size, and were made of earth and bricks. On the outer side is a very deep ditch, out of which the earth was dug for the walls. At Kha-beng the walls of a fort were traced up. Near Shanzooyean is the platform of a building surrounded by a very deep ditch. This is said to be the remains of the palace of the Talaing kings. Near it are ruins of a very large pagoda, and there are the remains of hundreds of pagodas and of some tanks, for miles round the slopes of the Konedan being strewn with bricks. This highland was evidently once the main land, the sea coming up to its base. A ship's anchor was once dug up at the foot of its southern slopes.

There are 13 waste land grants in this township under the rules of 1839-41 and 1863-65.

The grantees will now have to mark out their boundaries with masonry pillars, and there will not again be any doubt as to what is a waste land grant and what is Government land. In the past, grantees here, as elsewhere, seem to have been in a constant state of doubt as to their boundaries, and the want of a survey has often been a temptation to extend cultivation beyond limits which were not clearly defined.

There are no regular bazaars held anywhere in the township, except at Twantay. There is a cattle market too only at Twantay.

The table below gives the population by circles. The numbers of Talaings and Burmese are nearly equal. The Karens are numerous, being one-half of each of the others. The Shans are only numerous in Twantay and Kawhmoo Circles.

Population.

Circles.	Talaings.	Burmese.	Karens.	Shans.	Chinese.	Native of India.	Arakanese.	Total.
Twantay	1,757	1,413	1,004	1,120	38	122	3	5,484
Judpoora	140	530	313	33	...	...	...	1,016
Kawhmoo	2,951	1,907	553	706	99	203	...	6,419
Pyawbweh	1,117	4,850	1,859	15	36	107	...	7,884
Tan-ma-naing	1,328	1,056	...	2	4	1	...	2,391
Taw-Koo	1,555	1,122	45	...	13	68	...	2,803
Moke-yoon	2,427	1,229	180	...	2	21	...	3,859
Ze-pathway	3,530	1,039	56	526	...	80	...	5,240
Lawadee	2,226	1,066	1,255	133	24	192	...	4,896
Kodoung	737	2,262	1,618	108	14	27	...	4,766
Pan-hlaing	3,177	429	2,400	206	54	...	...	6,236
Khanoungto	1,365	4,050	146	322	5	44	...	5,932
Tamatakaw	570	1,303	426	273	3	...	...	2,575
Ma-hlaing	1,887	2,349	3,039	...	5	1	...	7,281
Total	24,676	24,635	12,894	3,444	267	866	3	66,782

Many villages have fine "Poungyees Kyoungs," or monasteries, and new ones are being built, which is a sign of the prosperity of the people. The Shway Tsan Daw is the principal pagoda in the township. The Talaings have a greater veneration for it than for the great Shway Dagone. It was erected some hundreds of years before Christ, and contains relics of Gaudama. It is small compared with the Great Pagoda, but it is gracefully shaped and picturesque. An annual festival takes place in March, when great crowds visit it.

At Engalon and Let-Kheik are fine prettily situated pagodas. These are two of the thirty-seven great pagodas of this township, which were originally built wherever the relics of Gaudama rested on their way to Rangoon. There is no large village without a pagoda.

This township being near Rangoon, many English customs are being adopted. In the narrow and very muddy streets of Ynathit, on the north-west corner of Pan-hlaing Circle, I saw a perambulator being rolled along with two naked Burmese children in it! At a village in this creek which was visited in the launch, I was surprised to see all the people deserting in a body, mothers leading away their children and carrying bundles on their heads. Presently the elders of the village came to complain that the smell of the engine was so disagreeable that they could not bear it, and must leave their houses unless the launch went away. I was getting up steam at the time and did not stay much longer, but I heard afterwards that the smell of grease is an abomination to a Burman. Going to Twantay by the Khanoungto creek we noticed white flags put up at a village on the side of the creek. On enquiry we found that the monks living near had bought up the fishing in front of their monastery, and that no one could fish between the flags, the taking of life being forbidden by the Buddhist religion.

The township is generally healthy. Tan-ma-naing is said to be feverish. Zeebyagoon and Oophoo and the other villages in the swampy Pan-hlaing Circle are unhealthy. The people at Oophoo have a fever-stricken appearance, and small-pox and cholera often visit this circle. When we were at Oophoo in April, twenty people had just died of small-pox.

There are no Government aided schools. At Twantay there is a large village school, and most villages have one, or the boys are taught in the monasteries. At Kamleng a Roman Catholic Missionary has built a school-house where a number of children receive instruction. This Missionary travels about among the Karens chiefly. These Karens readily embrace both the Christian and Buddhist religion.

There is a district post office at Twantay; from thence the post goes to Thongwa, the adjoining district.

There is a telegraph station at Elephant Point to signal the arrival of ships to Rangoon. The line runs up through the eastern circles. The telegraph building at Elephant Point has recently been removed a little way inland on account of the river cutting away its bank. There is also a tide-gauge station of the Survey Department at Elephant Point. The column at Elephant Point is a conspicuous land-mark for shipping. There is a light-house off the Ze-pathway Circle called the China Bakeer light-house. The Assistant Commissioner in whose division the township is included, lives at Kyouktan, in Syriam township. An Extra Assistant Commissioner resides at Twantay, where there is a court-house.

There are police stations as follows:—

	Number of men.
At Twantay	16
„ Kyektan	9
„ Tan-ma-naing	10
„ Tawkoo	9
„ Ze-pathway	9
„ Kyon Kyangon	9
Total	62

There is a guard-house of the Port Trust at Thakwotpeng, near the mouth of the Bassein creek.

Extract from the Annual Report of H. B. TALBOT, ESQ., *Assistant Superintendent, Survey of India, on the Tharawaddy District Survey—Season 1880-81.*

The Tharawaddy district was, till very lately, included in the Henzada district, with a subordinate court at Sa-ny-way and one at Mang-zye, and was very little cultivated. It has of late years made rapid strides, and the district is opening out, particularly all along the east. The Deputy Commissioner thinks that, as the land on the east is being taken up rapidly, the whole of the culturable area will be opened out in another 10 or 12 years.

The principal places met with are Thonezeh and Let-pan-done. Thonezeh boasts of three cleanly kept market-places (one old and two new), several shops kept by Chinamen, a Government school, a Police station, a Catholic and an Anabaptist chapel (with a school attached to each), a Railway station, and that curse to all nations—liquor shops—of which there are, I believe, two. Let-pan-done has a first class Railway station, with an indifferent refreshment room, a Police station, and a market-place. Both these towns have limits of townships marked, but the municipal laws have not been extended to them. Besides these, there are several large villages, particularly one or two along the Myit-ma-kha creek. This creek was the highway for the exportation of paddy before the Railway line was opened; the merchants carted their paddy to the creek, by which it was sent down in boats to Rangoon: even now, I believe, there is a good deal of paddy and dried-fish sent down this creek.

The principal rivers or creeks are the Myit-ma-kha and the Thonezeh; the latter is almost dry in the winter months, and being a hill stream, it rises and falls with the rainfall.

The main road runs parallel with the line of rail, from which branch roads run to the different Railway stations; these roads were all unmetalled when the survey was made, but I believe they are to be metalled with burnt bricks, and bridged: several of the bridges had already been built, and others were under construction.

The rail line runs about the centre of the district, north and south, and has a second class station at Thonezeh, a pick-up at Tharawaddy, a first class at Let-pan-done, and a second class at Tsit-kwin.

The principal inhabitants are Burmans, Karens, and a few Shans, who are also cultivators of the soil; the others, such as Chinamen, Chittagonians, and Sylhetians, generally reside in and about the large villages, such as Thonezeh, Let-pan-done, Tharawaddy, &c. The Chinamen generally keep shops, mostly of European goods, such as biscuits, sardines, pickles, matches, &c., &c., and liquors. The Chinamen are also good carpenters, and are invariably employed in house-building. The Chittagonians and Sylhetians keep petty shops of cloth, rice, ghee, and other native goods, such as the shops of the same kind in India.

I shall endeavour to give a few particulars regarding the Karens, their manners and customs being most interesting. They are of a retiring disposition, whether due to natural timidity or to the low estimation in which they are held by their more prosperous countrymen the Burmans, I cannot conjecture, but they generally inhabit the lands in the vicinity of the forest which they have reclaimed by their personal exertions. They are equally as industrious, and far more trustworthy than the Burmans. The soil is naturally so prolific that, after clearing the forest, the cultivators obtain from their annual savings a sufficient supply of rice to meet not only their own requirements till the following harvest, but are able to dispose of the surplus at such profitable rates for the Rangoon market, that they are in a position to purchase articles which, though useful in their way, would never, in their most visionary schemes, be thought of by the Indian ryot. The majority of the Karens inhabiting the country surveyed last winter are of the Christian religion—the Anabaptist persuasion—and the pure simple faith inculcated has elevated their character far above the average Burman. The larger Karen villages boast of a church of their own, which on week days is utilised as a school-room; the members of the congregation, young and old, assemble for divine service on Sundays and every night for even song. The service is conducted by one of the elders, and consists of translations into their mother-tongue, of prayers, and "Sankey and Moody's" hymns. On the whole, one must admit that the Missionaries have cast their seed into fruitful ground; their zeal and industry must have been untiring and are beyond praise. Secular education is not neglected either; in fact, in my opinion, the Karens are far more advanced than similar village communities in Upper India. English is not taught, but an elementary education in their own language is imparted. They have also picked up many old English tunes; passing through a village of an evening, I have frequently heard the Karen women singing at their work such familiar airs as "Annie Lisle," "Auld Lang Syne," &c.

The villages are mostly composed of a few planked huts scattered about irregularly. The larger villages are generally built in rows, having the roads paved with bricks. But the smell of putrid fish, used in the manufacture of *Gna-pee*, is disagreeably strong in every village, and it can be smelt at a long distance, particularly if the traveller is to the windward of the village site.

In the two hottest months, April and May, the wells commence drying, and the villagers are put to a great deal of trouble and inconvenience in getting water for their daily use. In the station of Thamwaddy there are only two wells that have a little water in each, and these

two have to supply the wants of the residents and surrounding villages. Mr. Jarbo informs me that, whilst surveying along the edge of the forests, he had to carry water with him, and had to make arrangements for supplying the camp when they finished their daily work, each man receiving only a certain quantity to cook his food with, as, he says, the water sometimes could not be had within two or three miles of his encampment

On the east of the district is the Pegu-Yoma range of hills, a tract of country averaging in width 10 miles from the water-shed to western base, sub-divided by the Forest Department into numerous blocks under reservation. The hills are covered with dense forests of teak, padouk, and other valuable timber trees, whilst the impenetrable undergrowth of cane, bamboo, and parasitical plants renders access to this region very difficult. For the convenience of contractors purchasing timber from the forest, a few dragging roads, 10 or 12 feet in width, have been made along the most prominent spurs; these roads invariably lead to the main streams, which, when in flood during the rainy season, are capable of floating the timber down to certain depôts established on the Railway line and elsewhere. This is the only method of conveying timber away from the hills.

Extract from the Narrative Report of MAJOR T. H. HOLDICH, R.E., *in charge, Survey operations, Northern Afghanistan,—season 1880-81.*

Throughout Northern Afghanistan, the triangulation was based on points, consisting entirely of mountain peaks, which had been fixed from within the limits of the frontier of India, by observations taken at long distances from the ends of short bases. These bases had, in most instances, been purposely selected, so as to be short enough to render the identification of the trans-frontier peaks certain. Hitherto these points had served the purposes of geography sufficiently well by defining the back-bone and direction of some of the principal Afghan ranges, but from the commencement of the last war, they became the initial points of a system of triangulation which gradually developed into two or three fairly distinct series, extending from east to west into the heart of the country. It was due to these points that anything approaching to exact surveys became *possible* during the early phases of the first campaign of 1878-79, as they enabled surveyors, to a great extent, to dispense with the preliminary labour of base measurements and computations.

But these trans-frontier points proved of very unequal value for trigonometrical bases, though sufficiently good for geographical data. They consisted of hill peaks, none of which had been visited, and few were sufficiently well-marked to be fixed accurately from the Great Trigonometrical stations, their distances from which ranged from 25 to 100 miles, thus it was not until the final reduction of all observations was undertaken that it was possible to define exactly which could be accepted for the purposes of initial data, in order to determine new values for the rest as a basis of topography. The original values of all of them are given in Synoptical Vol. I of the Great Indus Series.

"I do not think that, at the commencement of the campaign, triangulating officers started with a full appreciation of what might be effected with the 6-inch subtense instruments which answered the purpose, not merely of triangulating instruments, but, when used with the subtense pole, were used for pushing forward rapid traverses when the pressure of military operations prevented triangulation. Certainly the opportunity of using these instruments was at first far more restricted in Northern Afghanistan than it ever was in the south, where there was always a fair chance for survey enterprise. The use of heliotrope signals was almost an impossibility, partly owing to the introduction of heliography for army signalling purposes, and partly to the risk of detaching signallers; the hills were peculiarly rough and difficult of access, while they rarely offered any special mark or prominent peak for observation; and the operations of surveyors were of course limited by military exigencies which pressed upon them particularly hardly at first, in the preliminary steps of the triangulation, when it was all important that they should work on as wide a front as possible. Under such conditions it is hardly surprising that a well-connected series of triangles between India and Kabul was hardly thought of, either along the line of the Khyber or the Kurram; and yet results show that it is only by the want of observations at a very few points, that the final triangulation fails to resolve itself into such a series.

Working from day to day, through most varied conditions of atmosphere, and from peak to peak, without the possibility of erecting permanent marks; with only an approximate idea of the final direction of his work, bound by the necessity of remaining close to one line of route, and thus prevented from lateral extension, it was not always possible for a triangulator to estimate the exact value of the work he had in hand, or into what shape it might resolve itself when taken in conjunction with that of other officers working far away on totally distinct lines.

This was peculiarly the case with regard to the work along the two Kabul routes—the Khyber and the Kurram. On the more northern route the triangulation, which was commenced by Colonel Tanner and completed by Major C. Strahan, was based entirely on trans-frontier peaks, fixed from the Indus series; no continued series of triangles was kept up, and no base was measured. The western extremity of this branch terminates in three or four conspicuous peaks, fixed by intersection, overlooking the plain of Kabul; which peaks Major Strahan had determined to convert into trigonometrical stations as the Khyber column progressed

towards Kabul. But the work was suddenly suspended by the Treaty of Gandamuk, and on the second outbreak of the war, Major Strahan was unable to resume it. The positions of these final peaks were still uncomputed (owing to Major Strahan's dangerous illness after returning to India), when the thread of the work was again taken up in October 1879; and although Major Strahan's triangulation was connected with Kabul by myself, when the Khyber route was finally opened up, and sufficient points were laid down to serve the purposes of topography, yet, as I did not happen to utilise the exact peaks he had fixed on as trigonometrical stations, the junction was better effected subsequently when Colonel Woodthorpe brought the Kurram Series round, to close on those peaks.

The Kurram Series was also based on trans-frontier peaks, but not by interpolation, as was the case with the Khyber Series, but by direct extension from the base formed by two, of which the values appeared to be good in the Indus Series Volume. These two points were "Sangar" and "Khadimakt," both of which had been fixed by intersection from the Kohat Minor Series. Colonel Woodthorpe again determined their values, while *en route* to Thal, from points in the same series, but finally rejecting his own values, he worked from the base computed from the differential latitudes and longitudes, as given in the Great Trigonometrical Volume. Last season's triangulation in the Kohat district led to these points being visited and well fixed as trigonometrical stations, when it was found that the Great Trigonometrical Volume of Khadimakt needed revision, and a fresh computation of the entire series became necessary. From the initial base to a distance of about 100 miles, the series is carried pretty regularly to the north-west, including as one of its most northerly points, the peak of Sikarám on the Suféd Koh range. As Sikarám is about the most strongly fixed of all the Great Trigonometrical trans-frontier peaks in this neighbourhood, and as it is common to both the Khyber and the Kurram Series, it has been of great importance in connecting the two systems, and in furnishing to a certain extent a fresh point of departure for the Kurram triangulation. Unfortunately, beyond Sikarám, the Kurram series narrows to a single point on the Shutargardan Pass. No permission could be obtained from the military authorities to visit peaks on either side, and consequently the Kurram series from this point depends for its extension on one or two unvisited lateral peaks, which furnish triangles of which two angles only have been observed, and which appear to be of a very indifferent class for recognition. In each case there is room for doubt whether the points observed north and south from Shutargardan are absolutely identical with those on the same hills observed east and west, before and after reaching the pass. It is probably due to the shape and direction of the ridges that a slight difference on the point observed introduces no appreciable error in the linear values of the common sides when computed first by means of points north, and then by those south, of Shutargardan. The agreement in linear value is very fairly good, but the sides of the triangles being comparatively short, the non-identification of the exact point of observation in each case has introduced an error in azimuth, which here becomes apparent for the first time, and which it is impossible to account for in any other way. After passing Shutargardan the series emerges into the open plain at Kushi, and from there to Kabul there exists a strong net-work of triangles, based on peaks of great altitude, which may be classed as being as good as any minor series in ordinary topographical work. From Kabul the triangulation extends eastwards until it joins on to the Khyber series, Colonel Woodthorpe having succeeded in reaching one of those peaks overlooking the Kabul plain, which Major Strahan had laid down as a forward station for his own series, but which, of course, he had never visited. Here, then, a strong junction could have been effected, which would have fairly turned the difficulty at Shutargardan had Lieutenant-Colonel Woodthorpe been able to identify Major Strahan's stations. But the means were wanting. No plane table chart of Major Strahan's triangulation, which would have at once indicated the peaks in question, was then forthcoming; and the opportunity, thus lost, never occurred again. Such is the nature of the Afghan mountains, that prominent peaks were most rare, and difficult to find. Indeed, there is no one peak throughout the entire breadth of the country that offers a point for observation such as can be called first class. Lieutenant-Colonel Woodthorpe multiplied his observations to the greatest extent that time would allow, sparing no pains to hit off the exact spot (unmarked in the hazy distance) on which he had himself previously set up his theodolite, or which might be the station of some other surveyor. It is owing chiefly to the multiplicity of his observations, and their careful minuteness, that such results have been obtained as are now included in the General Report; but yet, where he had no plane table chart to narrow down the limits of his observations, he sometimes failed, as he failed in this instance, to recognise the exact position of Major Strahan's stations. Unfortunately he was prevented by clouds from identifying Sikarám Peak at the same time. Thus the junction with the Khyber series was weakened so far, that there was very little choice as to weakness between that point in the circuit and the other weak point to which I have referred at Shutargardan. The triangulation which I had myself carried through between Major Strahan's stations at Gandamuk and Kabul was too weak for the main purpose of connecting the two systems, for exactly the same reason. I had failed to recognise the precise position of Major Strahan's stations. This difficulty, in triangulation of this nature, is one which must be specially noted; with a chart there is no great difficulty; without it, the whole experience of these surveys shows that it is only by a rare chance that any man picks up the position of another surveyor's station, when he has to depend on description only, and such a monotony of mountains as exists in Afghanistan.

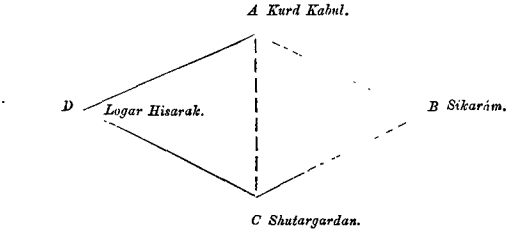
The computation of the Kurram series (accepting the values of the Khyber triangulation, furnished by Major Strahan as final) from Kohat to its junction with the Khyber, has occupied

much care and time. Many tentative computations have been made in order to test the values of initial azimuths and bases by results, when the computations were brought to close on a well-fixed Great Trigonometrical trans-frontier peak. With a series of irregular triangles, where, in nearly all cases, a triangular error can be traced with far more probability to the weakness of one angle than to any general error distributed between the three, any rigid method of apportioning such error seems out of place. The adjustment, in this case, has consisted far more of a careful examination of angle books, and balancing of possible influences of time, opportunity, atmosphere, and position, than of the adjustment of errors in graduation and level. The final results are fairly satisfactory, being more exact, indeed, than anything that was contemplated at the outset of the survey. The Kurram series was finally brought to close on a long side between the Kurd Kabul Station and Korogh H. S., while the Khyber series was so extended from Major Strahan's bases as to close on the same side. The agreement of the two values was exceedingly close (agreeing to a single foot), much closer indeed than the nature of the survey operations can really warrant.

But although the linear agreement was so far satisfactory, the computation of the Latitudes and Longitudes of the final points in each series did not lead to quite such accordant results. This, of course, is due either to the gradual accumulation of small angular errors affecting the value in azimuth of the sides of the triangles composing one or both series, or, more probably, to one considerable error of 2 or 3 minutes, which has been so applied in the course of computation that its whole weight is perceptible in azimuth, while it has had little or no effect on the linear values.

There are various points in the two series at which this might possibly occur, but of all of them, it seems more probably to be due to the weakness of the Shutargardan link in the chain, where there are several successive triangles of which two angles only have been observed, than elsewhere; at the same time it is not safe to assume this as a fact, because of the weakness already referred to in the Khyber line computations at the junction of the work of successive seasons. Major Strahan's final values in azimuth are implicitly to be trusted, as he has taken a most elaborately careful series of observations for azimuth so near to the end of his work as to leave no room for errors to creep in. If similar observations could have been taken anywhere between the Shutargardan Pass and Charasia, the adjustment of the difficulty would have been easy enough, but the opportunity for such observations was wanting, and the position of the error can only be surmised.

The linear values of the two series being in accord, and the points Sikarám and Kurd Kabul being common to both series and furnishing the means of proving that azimuthal values agree in both up to that point, angular values for determining all azimuths west of Sikarám are obtained as follows:—



All four sides in the above quadrilateral are computed linear values, Sikarám not being visible from Logar Hisarak, nor Kurd Kabul from Shutargardan, but the angles B, C, and D being observed; the side A C is computed by means of A B, B C, and the angle B; and also by the sides A D, D C, and included angle D. The two resulting values differ by about 200 feet in a total distance of 33 miles, the angle C being merely used as a useful check on the results.

With the angular values of the quadrilateral thus obtained, the value of D in Latitude and Longitude is computed from A and C, with the result of an absolute agreement in Longitude, but of a difference of about 2″ in Latitude. The mean value in Latitude being accepted in order to bring the two series to common terms, the point D (Logar Hisarak H. S.) is adopted as the origin for all values of points on the Hindu Kush, Kohi Baba, and Paghman ranges west of Kabul. Of course these positions are but approximations after all; but as, finally, the probable absolute error in position of any one of them does not amount to more than one or two seconds (100 or 200 feet) either way, and considering that the actual summit is often difficult to define within these limits, this is quite near enough for all purposes of topography in future.

Simultaneously with the computation of the Northern Afghanistan Triangulation, the reduction of the observations in Waziristan has been completed, and these have an important bearing on much of the Kurram and Khost Surveys, and to a certain extent form a connecting link between the triangulation to the North and that of Southern Afghanistan. The westerly peaks of Waziristan overlooked a large tract in the very heart of Afghanistan, which has

so far been a blank in the maps of the country. Between Western Waziristan and the great high road joining Kabul and Kandahar there are no very important ranges, and the topographical features of the country generally may be described rather as rugged and hilly than as mountainous; so that there was some difficulty in fixing the position of points of sufficient prominence to be readily recognisable, especially within the very narrow limits of time that could be allowed for the observations. The altitude of the peaks which could be reached by the Survey Officers was either so great as to leave very little time for observing, or they were situated in ground occupied by the Mahsud Waziris in force, and time was lost in the necessary disposition of the supporting guards. Pir Ghal (11,500 feet above sea level) is the highest peak in India south of the Himalayas, and Shuidar (11,000) was held by the Waziris, who attacked the Survey Party at the very summit of the peak. But in spite of the want of time for observing, a certain number of points were fixed from these and other peaks, within that blank space; and other observations were taken, which have proved of great value in checking the position of many important peaks in North Afghanistan, which would otherwise have been indifferently fixed. To the south-west, observations were obtained across the intervening space of 170 miles to the great southern peaks of Kund, the centre of the Kojak mountain system; and many bearings were recorded which will be useful checks on exploration traverses, such as that carried by the native surveyor along the Zhob and the Gumal to Lake Ab-istada, or on the more exact traverses of Lieutenant Gore, R.E., and others between Kandahar and Kabul.

This combination of the work of different surveyors working over a vast extent of country, on entirely separate lines, such as the Khyber, the Kurram, the Khaisor, and the Bolan, all more or less parallel (running from the north-west frontier westwards into Afghanistan), and thus affording the chance of combination by observations to intermediate peaks, has been useful in pointing to certain conclusions which may serve for future guidance.

Although the possession of a number of fixed points from which to interpolate at once secures the necessary basis for a survey, yet it is worth while to note that the value of such a starting point for a series as can be gained by interpolation from intersected peaks only is an exceedingly troublesome one to compute. For if the same weight is to be given in the first instance to every one visible of the surrounding fixed peaks, they must be taken in combinations of three for the purpose of computation, each combination resulting in a definite, but possibly fictitious, result, differing from the others in proportion to the inaccuracy in the value of one or more of the three peaks. If there are many such combinations, their resulting values for the interpolated point form a small figure, of which the centre of gravity is the best approximation to the true position of the interpolater. But the position of the peaks, with regard to the observer, and the angles of intersection at the point of interpolation, have also to be taken into account; so that it becomes a very difficult matter to regulate the weight of each peak in the final computation. The result, after all, is probably frequently no better than that gained by ordinary interpolation on a carefully projected plane table, when the value of each peak is instinctively estimated by the observer from actual observation on the ground, and the final point of interpolation, which he assumes as the correct one, can be measured off by co-ordinates from the graticule lines.

Each surveyor working along a line of his own in an unsurveyed country where all information is of importance, and where his work may in future either combine with that of others or be continued by another observer, should certainly, if he can possibly manage it, carry on a plane table chart of his triangulation in combination with his observations. The assistance that this affords to the officer who succeeds him, or who has to close on his work, or to compute his observations, is incalculable. In the first two cases it is absolutely essential to a good junction, and in the last it has been found that the plane table furnishes a most valuable record of approximate distances leading to the identification of many points which would otherwise remain uncomputed. It is often exceedingly difficult to estimate the distance of a peak, in miles, from the observer, when it is a matter only of judging an abstract distance under varying conditions of atmosphere, but it is simple enough to put down an indication of the shape and nature of a peak on that approximate spot on the chart which it should occupy relatively to other peaks whose positions are already projected, and which can be seen from the point of observation. Many points of great value, thus estimated and sketched on the plane table, have been found also recorded in the angle book; and they have been recognised again, without difficulty, by their indicated position and shape amongst similar records by other observers observing from other points. Some of them have been fixed by the intersection of two rays only, the observations being taken by different observers, but the plane table record leaving no reasonable doubt as to the identity of the object of intersection.

Another point of evident importance is, that observations should be taken from, and to, the highest point of the peak or hill. This is a recognised rule in all topographical surveying, but its importance is not always recognised by military authorities when supporting a surveyor in his work. No other point can possibly be of the same value to other observers. In a great majority of cases, where a station was made on the slopes of the hill, or was covered by some projecting rocky peak, it has proved useless as a link in the main chain of the series, being merely useful to assist in intersections.

Observations for altitude have proved exceedingly useful in the combination of the work of different surveyors. The computation for height does not involve such very minute accuracy as to length of base, but that the result is generally near enough to indicate whether the point is the same as that observed by another observer, or not. A very rough approximation to the

distance will generally decide this. Consequently the most important of the far-off peaks that are recorded in a round of observations should be those most carefully observed for altitude. Coincidence in the value of heights is almost a better check on an intersection than coincidence in the matter of estimated distance.

With regard to astronomical observations, those for the determination of azimuth have proved of far the greatest importance in the reduction of the North Afghan computations.

The combination of the work of surveyors with that of signallers is another point to which attention has first been drawn in Afghanistan. The use of the heliograph in the field to a certain extent prohibits the use of the heliotrope, which is ordinarily used by surveyors, because of the confusion that might possibly arise between the flashes from the two instruments. But it almost always happens that points suitable to a surveyor are suitable also for signalling purposes. The conditions which the surveyor hopes to find fulfilled by ascending a commanding point are just those most valuable to the signaller also. Signalling can but be carried on by means of large glasses and long rays, because fewer men can thus keep up communication along a given line; the chief difficulty in maintaining signalling operations being the necessity of guarding each post. But long rays can only be obtained from the highest and most commanding peaks, just the points which the surveyor is always striving to reach. Only with the assistance of signallers (when the use of the heliotrope is forbidden) can one surveyor hope to make known his whereabouts to others working at a distance; and when communication can thus be established between them, the value of their observations is very largely increased.

The general results of the computations for altitude are such as tend very much to shake confidence in barometrical observations. From the Indus valley series to Kabul a double line of reciprocal trigonometrical observations were taken, from peak to peak, along the entire length of the Kurram series, and the finally computed value of the height of the Sher-darwaza hill station at Kabul differs by only 2 feet from that determined by Major Strahan by interpolation from surrounding Great Trigonometrical points. This result must therefore be regarded as a close approximation to the truth. But it has the effect of lowering previous estimates (based on barometrical results only) very considerably. The face of Afghanistan about Kabul, including the peaks of the Hindu Kush, has diminished in altitude above sea-level by about 500 feet. About Jalalabad the values remain much the same. The value of refraction resulting from Major Woodthorpe's verticals was found, on the whole, to be somewhat greater than that usual in the plains of India. Expressed in decimals of the arc contained between any two points, it amounts to about ·0 in Afghanistan, which, contrary to the usual rule of diminishing refraction with increase of altitude, is somewhat in excess of the nominal value of $\frac{1}{15}$ or ·067.

Account of the Survey Operations in Northern Afghanistan, including Waziristan, drawn up by J. O. N. JAMES, ESQ., *Deputy Superintendent, 3rd grade, Assistant Surveyor General.*

The officers deputed to accompany the expedition against the Waziris were as follows:—

Major T. H. Holdich, R.E. ... } With the Bannu Column under Brigadier-General Gordon, C.B.
Lieutenant the Hon'ble M. G. Talbot, R.E. } With the Bannu Column under Brigadier-General Gordon, C.B.
A Sub-Surveyor ... } With the Bannu Column under Brigadier-General Gordon, C.B.

Captain Gerald Martin, S. C., with the Tonk column, under Brigadier-General Kennedy, C.B.

Major Holdich, who was in charge of these operations, reports as follows:—Captain Martin "commenced plane-tabling on the 18th April, and carried on a plane-table survey extending to some distance on both sides the route, which, as far as the village of Sarfaraz, covered more or less the ground which had previously been surveyed during the advance of General Chamberlain's column (1860). * * * From Sarfaraz the route diverged by the Nari-Ragza Tangi (defile) into the Khaisara valley, and the mapping covered entirely fresh ground. * * * After passing through the Waziwood over the Sawangai-Kotal (pass) down into the Baddar valley, near the villages of Spirki and Moghal-khel, old ground was again struck into, and a junction effected with previous surveys. In addition to the mapping, which may be roughly estimated at 300 square miles of new country, as well as a considerable overlap into previous work, Captain Martin obtained most valuable trigonometrical observations from three hill peaks—Kargundi, Kundigarh, and Pirghal, which will have an important bearing not only on the work of explorers on the lines of Zhob, the Gumal and the Kundar Rivers, but will combine with the observations made by Surveyors attached to General Gordon's column, in fixing points for future reference, and extension of survey in the Kharoti and Zurmut districts."

Major Holdich, while General Gordon's Brigade was encamped opposite the Khaisor Pass at Miran, was able to send a Native Surveyor under political protection to the Gabargarh range, "which, from its commanding height, afforded a good opportunity for starting the topography of the unmapped portion of the Waziri district. He remained about three days on the hill and succeeded in mapping the rugged line of peaks of which Gabargarh is composed, and in overlooking some of the watershed of the Sheranna and Shukto."

A Native Surveyor was also able to visit and map the Shukto basin south of the Khaisor nalla, an area of nearly 500 square miles, which has hitherto been a complete blank on our maps, work which could not have been undertaken by any European officer without risk, and difficulty in providing military escorts. Major Holdich also reports that "the advance of General Gordon's Brigade to Razmak gave further opportunity for topography to the north of the Khaisor line along the watershed between the Khaisor and the Dawar (Dour) valleys, which had hitherto been unmapped. Lieutenant Talbot, R.E., plane-tabled this part of the country, and experienced no great difficulty in reaching the chief points along the watershed, from which a very fair view of the Dawar (Dour) valley was obtained. His mapping is a southern continuation of the Khost mapping which was executed by Lieutenant-Colonel Woodthorpe during the Khost valley expedition under General Roberts, so that there remains now no gap on this part of the frontier. Of course much of the Dawar (Dour) valley was seen from a distance only; but the topography, on the whole, was easy, the natural features of the country being large and clearly defined, so that Lieutenant Talbot's work may be accepted as a very fairly accurate record of the valleys of upper and lower Dawar." Major Holdich reports that the total area of fresh mapping obtained on the scale of ½ inch to the mile covers 1,200 square miles, and in addition there was surveyed about 300 square miles of overlap, and eye sketches on a smaller scale, of the country west of Waziristan. Observations with the theodolite were taken along the line of peaks on the western extremity of Waziristan, overlooking the still unexplored districts of Zurmut, Katawaz, and country of the Suliman-Khels, which had not been seen at any time during the late occupation of Afghanistan. Observations were also taken from points more to the north, and these will, it is expected, serve to fix the Jadran and Kohnak ranges and the hills about the Paltu pass. The season was favourable for such observations, and every opportunity that offered was availed of by Major Holdich, Captain Martin, and Lieutenant Talbot to fix points beyond the limits of the country visited, which will be very valuable to future geographers and explorers.

The Native Surveyor rendered excellent service during this expedition, and Major Holdich states that the value of his work can be guaranteed.

In connection with these operations is the exploration by a native explorer of the country between the Suleiman range and the Ab-i-Istada. The rough map he has completed covers 7,140 square miles, but a considerable portion of this area is country which he only saw and sketched by the eye, yet the information he has obtained is valuable and materially alters the conjectural geography which has hitherto appeared on all maps, especially in the Zhob (Jobh) and Gumal basins. The following account drawn up by Lieutenant Talbot from the explorer's notes describe the country he visited and the people inhabiting it:—

Account (drawn up by LIEUTENANT THE HON'BLE M. G. TALBOT, R.E., *Assistant Superintendent, Survey of India) of Explorations in the Zhob and Gumal valleys.*

Sherannis.—The Sherannis are a tribe of Pathans living in a hilly tract of country, bounded on the east by British territory, south and south-east by the Ushtaránas and Musakhel, west by the Haripál, and north-west and north by Mando-khel and Waziri. Their country contains several lofty peaks, of which the highest is Kaiseghar (corruption of Kaisarghar), then Takht-i-Sulimán Warmomezai, Michenghundi, Shinghar and Zawaghar.

On Kaiseghar the snow remains for two or three months in the year, and on the other hills a lesser time, according to the height. The Takht-i-Sulimán proper is a niche in the rock, about 10 feet below the summit, looking as if it had been cut out by hand. In front of it is a small ledge, below which the hill falls precipitously. There is a ziarat on this ledge, consisting of a few stones and two or three upright holes. The legend is that King Solomon used to cause himself to be transported by genii to this place and sit there to enjoy the cool air. The Hindus have a legend that a certain Pailád was hurled off the top by Hirna Kas, and managed to save himself from falling down the precipice by clinging on to the ledge: they call it Pailád-ka-Asan. Many people of both religions visit the place. Close to the ziarat there are a couple of small huts, containing a few cooking utensils left for the use of pilgrims. There is no spring near the summit, but after rain the water collects in some holes in the rock, and there are two hollowed-out trunks of trees placed so as to catch the rain running off the hills, and capable of holding two or three mussuks full. The summit of the hill does not form a single peak. There are three points, much of the same height: the centre one is the Takht, and on it there are some large pine trees. The southern point is only about a chain distant, and very slightly higher. The northern one is about 8 to 10 chains distant, and slightly higher than either of the other two. The Takht is very precipitous on all sides; the road approaches it from the north, and, near the top, winds round up the western side. Some labour has been expended on the road, but it is impassable for animals, and a man unaccustomed to hill-climbing would hardly be able to ascend by it without assistance.

The Sheranni country is drained to the east by three streams: the Dráband, Dahána, Khedarzai, and Dahána Musazai. The Dráband has always got running water, and after heavy rain is impassable for two or three days. As far as Drázán and the Hassanzai country there is an easy road for troops; beyond that, waterfalls are met with, and, though a single man might get round them, there is no practicable road. The Khedarzai road, coming from the west, crosses an easy kotal of 3,000 or 4,000 feet. Close under the Takht there is

a difficult place of 2 to 2½ miles long, which has to be repaired yearly by the Povindahs. On the western side of the Kotal the road divides: one branch goes to the west by Kuri and thence on to Shilghar and Katwás; the other, to the south-west, goes to Gharlamma and up the Zhob valley. There is also a road to the north of the other two, called the Záwalár, used chiefly by men from Tirik and Tamak. This is said to be better than the others. Both these roads are bad near the hills, having a constant rise and fall; but loaded animals can and do pass by them. The Musagei road is better than the Khedarzai, but it also has to be repaired yearly. It is used by people going to Dehra Ghazi Khan.

The Sherannis possess very little plain country. What crops they have are mostly irrigated from streams. They have the usual two harvests, from which they get wheat, *makki*, barley, *shina* or millet, rice, *kangani* (a sort of millet), *jowar*, *samak*, cotton, and water-melons. On the hills are found the *nishtar* or *chilghora*, the lime, wild olive, *fula* or *palo*, a shrub eaten by camels, *luni*, *dhaman*, *samalu* (a shrub producing edible berries), wild onions, *ghina* or *kangar*, a plant with leaves like those of the *nim* tree, and a small edible berry. There is excellent grazing on all the hills,—consequently, camels, cows, donkeys, sheep, and goats are very plentiful. Horses are scarce.

The women wear no pyjamas, only a long gown. The Sherannis export into British territory, *chilghozas*, fir-poles, *ghee*, tar from the *chilghoza* and from the *chir* (the former being the best; both are called *zeran*) and *ganda-barosa* from the *shina* and *chir trees*. They receive in exchange cloth, oil, sugar, spices, and tobacco. They are armed with matchlocks, pistols, swords, and shields, all of which are obtained from India, as is also their lead; powder they make for themselves. The following diseases are prevalent amongst them:—Impotence, fever, spleen, jaundice, sciatica, cataract. Besides the Takht-i-Suliman, they have no other stronghold to retire to. Their chief villages are Dráján, Pasta and Karam, each of which may have 100 to 200 houses. Most of the other inhabitants live in small square forts with towers at the angles. Hindu traders are found in the villages; also blacksmiths, carpenters, durry-makers, weavers, mochis and barbers.

Marhel.—The Marhels are a Pushtu-speaking tribe of about 1,000 men; they are acknowledged as Pathans by other tribes. They inhabit a low-lying country bordered on the north by the Mando Khel and Haripal, east and south-east by Musakhel, and south and south-west by Kākars. They grow some crops, but get their chief subsistence by trading from Kandahar and the Kākar country to India. They lead a migratory life, spending the hot weather in their own country and the cold weather in India. They have large flocks of all sorts, and consequently are rich and live well. They are hospitable to strangers. They are light complexioned. They are all armed. Some of them have percussion muskets; but they are at feud with nobody.

Haripál.—This is a Pushtu-speaking tribe, not of Pathan descent, of about 700 men. They call themselves fakirs. They have no feuds with any of their neighbours, and are allowed to travel freely. They inhabit a small tract of country to the west of, and including, the Shinghar, the only hill of importance in their territory. They are bordered on the north and west by the Mando Khel, on the east by the Sherannis, and on the south by the Maihels. They inhabit houses during the cold weather and huts in the hills in the hot season. Their food is very poor, and they do not feed strangers. They clothe their women and girls properly, and do not send them out in charge of flocks; they have, however, to collect wood and grass. Their chief is Mullah Abdul Hak. They have both irrigated and rain crops, from which they obtain the same produce as the Sherannis, and in a few places they have mulberries and grapes. The hills produce the same trees and shrubs as in the Sheranni country. The climate is good,—not so cold as the Sheranni country. They have camels, donkeys, and lots of sheep, but few goats. They suffer a good deal from fever; also from indigestion and cataract. They carry assafœtida into British territory by the Dahāna Khedarzai, and receive cloth, &c., in exchange.

Mando Khel.—A tribe of Pathans, numbering about 5,000 fighting men. Their country extends from Gardao Maidan on the north up the Zhob as far as Sarob on the south, and from the Häripál on the east stretches away in a long narrow strip to the west as far as the Gusdoë range and Nāmakāni. Those of the tribe who live near the Zhob have fertile lands and are well off, but those who live near Nāmakāni are very poor and subsist chiefly on chilghoza and shina. There is a great deal of plain in their country, and they have flocks of all sorts They pay a tribute to Dost Mahomed Khan, Kākar, of one sheep from each flock or *rammak*. There are two large hills in their country (Gusdoë and Sheraghar) and many small ones. There are three streams: the Zhob, Mekhchan, and Sheran. The water of the two latter is bitter. The Mando-khels have a feud with the Sherannis, and, when at peace with them, come into British territory; they also bring down salt for their own use from Karez-i-Sidi. Their country is warm, and they have the same trees and crops as the Sherannis. The roads through their country are up the Zhob, up the Sarob, and the Záwalār; they are all easy, open going. The water, as a rule, is bitter in the highlands and sweet at a low elevation. They suffer from the same diseases as the Sherannis. When a man has a bad fever, they put a fresh sheep-skin on him as a blister; instead of jalap, they take ghee. There are Hindus, blacksmiths and durry-makers, in their villages.

Kākars.—The Kākars say that they have 20,000 fighting-men, but have not more than 16,000 or 18,000. Their country is bordered to the west by the Peshin; to the south, by Lunis and Marris; to the east, by the Baluch, Bozdar, Musa-khel, Isot and Mashel tribes; north, by Lohāna, Bābar and Mando Khel: north-west, by Tirik. From north to south it is about 40 miles wide, and 100 miles long from east to west.

The Kākars are a rich tribe, and have no poor; they have both irrigated and rain crops. Besides the usual crops, they also grow tobacco, onions, carrots, muli, and manit. They have a few gardens, in which they grow pomegranates, pears, mulberries, and grapes. On their hills grow the wild olive and a sort of cypress, but no pines. Their country includes large open plains with lots of water from karez and springs; they have lots of camels and other animals, and when at peace with the Marris they trade to Kelāt and Dādar; otherwise, they bring their goods into British territory by the Vohoá pass to Dera Ghazi Khan and the Dahāna Musazei to Dera Ismail Khan. They build good houses and forts of mud and stone, and remain in the same place during summer and winter, and have two large towns,—Khushnob, where the sardar lives, and Mena, where his Deputy lives. There are also two large villages in the Bori Valley, that are called Dihli and Lahore.

The Kākars allow no strangers into their country on any pretence. Mena is the largest town, and contains about 300 houses; Khushnob has about 200. In each of these towns there are about 100 houses of Hindus. There are also carpenters and blacksmiths.

The Kakars are well armed with matchlocks and talwars, and some of them have percussion muskets.

Bābars.—This is a small tribe of graziers, numbering about 1,000 men. They live chiefly in the Mekhchan Valley, and have no high hill besides Māzhob. They have one town near Mena called Gardao, of about 100 houses, with some Hindus in it; there are also a few gardens and fields near it, but the Bābars do little cultivation: they are poor and badly dressed, like the Sherannis. Any man who has animals trades with India. They live very poorly, and consequently suffer more from disease than other tribes. They have no artizans; each man does what he can for himself, and they pay a tribute to Dost Mahomed Khan Kākar, of one sheep from each *rammak* or flock.

Sohāna.—This is a tribe of about 1,000 men, living in the Kundar valley. They call themselves Pathans. They live chiefly by agriculture, but they also keep flocks, and some of them take salt for sale to the Kākar country. Their country is rather cold. The water of the Kundar is mostly bitter, but here and there you find springs of good water. They have no built villages, but wander about, pitching their tents where they like. Here and there they have *karez* (underground irrigation).

They are very poor indeed, but if they have food, will share it with strangers. They are badly dressed, like the Sherannis, and their head men are Mullah Kamāl and Mullah Saleh. They suffer from the same diseases as other tribes. If any one dies, they kill and eat a sheep on his grave. They pay a tribute to the Kākars. They have no feuds with any tribe.

Tirik.—This is a tribe of Pushtu-speaking men, not Pathans, numbering about 10,000 men: their country is bounded on the north by the Sulimān Khel; on the west and south-west by the Ghilzais; south by the Kākars; and east by Lohānas. This is a cold country; snow is liable to fall in any part of it. It contains no big hills, and is chiefly open plain country, without grass; the Wāli Margā is its largest stream. The Kakars have lots of cultivation and a few gardens, and grow the usual crops. There are a few karez. These people make poshtins and caps, and trade with India. This tribe is rich, and Sher Jahān is the name of their chief. Thabī Khel, containing about 200 houses, is their largest village; they are usually at war with the Sulimān Khel, but at present they happen to be at peace. Those near Shilghar pay tribute to Kabul.

Nāsir.—There is a small tribe of this name, of about 60 men, who live between the Tirik and Sulimān Khel. Dost Mahomed is their head-man. They have good crops and a strong fort, and have a feud with the Sulimān Khel. They are hospitable and friendly

Andar.—The Andar tribe live in Shilghar, near Ghazni, and close to the Abi-Istada and above Katwās; they number about 18,000 men. The Chief is Sher Khan.

Sulimān Khel.—They live in Katwās, and number about 20,000 men. Their chief's name is Khan.

Nāsir.—This tribe lives in Shilghar and Mukur, number about 10,000 men. Chief is Abdulla. (These Nāsirs are a larger section of the same tribe mentioned above.)

Dutāni.—A tribe of about 800 to 1,000 men, live about Ghazni. Chief's name is Hatim Khan.

Niāzi.—A tribe of about 500 men, live in Shilghar. Chief's name, Hāji Habibullah.

Lohāni or Miān Khel.—Live in Shilghar. A tribe of about 6,000 men. Aladad is the name of their chief.

Kundi.—A tribe of about 400 men, live in Mukur.

Mathi.—A tribe of about 300 men, live in Katwās.

Khaist.—A tribe of about 4,000 men who live in Shilghar. Their chiefs are Āmīr Khan and Attagul.

Lohani.—A tribe who live in Katwās.

The tribes that live in Shilghar are all more or less subject to the Andars, and only live there on sufferance.

Roads in the country explored.

From Dost Mahomad Nāsir's fort there is a road leading to Quetta and Pishin, and another to Kelat-i-Ghilzai, both pretty good. About 12 miles north of Dost Mahomed's fort is a fort belonging to the Alizai tribe. Its inhabitants pay tribute to Kabul. Its name is Wazkhwa, and about 13 miles to the north-west is the Abi-Istada, a lake about 12 miles

long and 6 or 7 wide. From the Abi-Istada there is a road to the north by Gwashta-Sar to Mukur and Ghazni, another by Sakirasar to Mukur, and also a straight road from Gwashta by Katwás to Ghazni. All these roads are pretty good.

Two large streams come from the north and fall into the Abi-Istada; one, called Rūd, from Ghazni and Shilghar; the other, called Nahar, drains Katwás. There is a road from Ghazni through Daurtalfi across the north end of Katwás through the Suliman Khel country down into the Gumal, and another road passes through Shilghar and Katwás, and falls into the Gumal. A road passes through Katwas into the Kandīl stream, then on by the Shiran into the Gumal.

Other roads come to the south of the Abi-Istada by Sakira-Sar and Dost Mahomed's fort, on by the Shiran into the Gumal. The Tamak Ghilzais and Kandaháris use a road by Sáleh Kārez, which joins the other roads at the junction of the Kandīl and the Shiran.

Report on the operations in Southern Afghanistan by Brevet Lieutenant-Colonel E. P. Leach, *V.C., R.E., Assistant Superintendent, Survey of India—Season 1880-81.*

In my report of the previous year, dated Kandahar, 8th December, I explained how far I hoped to be able to replace the survey material, maps, &c., lost during the retreat from Maiwand, and the withdrawal from cantonments.

These expectations—thanks to the energy of Lieutenants the Hon'ble M. G. Talbot, R.E., and F. B. Longe, R.E., who joined me from Kabul with General Sir F. Roberts' force—have been fully realised, and there is now no gap in the continuity of the various reconnaissances executed since the commencement of the campaign.

In May 1880 I had been able to extend Captain Hobday's survey of the Khakrez valley eastwards, towards the Hazara districts, lying north of the Argandáb. The field sheet was unfortunately lost, but a duplicate sheet, with a few points projected, enabled Lieutenants Talbot and Longe, during the temporary detachment of a portion of General Phayre's division to Dáhla in October, to obtain a complete re-survey of this portion of the Argandáb valley, and to extend the previous triangulation over a far larger area than it had previously covered.

In January 1881, during the temporary occupation of Maiwand by General Wilkinson's brigade, the same officers were enabled to recover and extend the observations previously taken by myself in that district, and by means of these observations Captain (now Major) Rogers' Khakrez valley triangulation, Captain Hobday's Kandahar work, and their own observations subsequently taken at Jakán, a high point in the Tarnak valley, connected with the Quetta series, a symmetrical net-work of triangulation has been obtained, and a continuous chain of well fixed points has been extended from Girishk eastwards to the Koh-i-Mazár, a magnificent snow peak in the Hazara country at the head of the Mian-i-shin valley.

In December, Lieutenants Talbot and Longe had visited the three terminal stations of Major Rogers' Quetta series, and completed the observations necessary to effect a satisfactory junction with Captain Hobday's Kandahar triangulation; and during the recess, assisted by Captain Hobday, the latter officer has been continuously employed in reducing the whole of the observations to the terms of the Great Indus Series.

The results are embodied in a volume drawn up in general report form, in the introduction to which will be found the comparative values of stations, &c., common to each officer's work, and the method adopted in finally reducing discordant elements. A chart has been prepared to accompany this volume, giving all points trigonometrically fixed north of the Khojak by the officers above mentioned, as well as the less accurately determined peaks fixed by Lieutenant-Colonel Campbell in the Khelat-i-Gilzai district, and by Major Beavan from Girishk. The latter points were found sufficiently accurate for small scale surveys, but were based upon a long length of traverse line and an observed azimuth from stations which unfortunately I never had an opportunity of connecting with our subsequent triangulation. This was the more unfortunate, as during the occupation of Girishk by Sir M. Biddulph's force in 1879 the weather had been brilliantly clear, and Major Beavan had obtained observations to snow peaks over 200 miles distant.

A final map on the scale of $\frac{1}{4}$ inch to the mile, based upon the combined triangulation, and the various reconnaissances published during the years 1879 and 1880, has now been completed, with additions from Wilson's map, and information obtained from native sources. Much of the material used is subject to future revision, should opportunity occur; but a marked distinction has been made between all work which is approximate only, and the more reliable surveys of the officers mentioned.

In September 1880 a large scale plan of the city of Kandahar on the scale of 6 inches to the mile was commenced, intended mainly to illustrate the operations round Kandahar itself, and to show the positions occupied by Ayub Khán's troops during the siege. This survey was subsequently extended in every direction and continued till the end of March 1881. It embraces an area of 65 square miles, and reflects great credit upon the native surveyor, Munshi Abdool Gufár, by whom it was entirely executed.

During the same period, excellent large scale plans of the citadal of Kandahar, the walled villages of Deh Khwája, Bála Karz, Karz, Chitul, Dukhtarán, &c., were made by the guides of

the Quartermaster-General's Department, who were most kindly placed at my disposal, in the first instance, by Major Adams, Assistant Quartermaster-General, and subsequently by Major Jopp, Assistant Quartermaster-General. To both these officers I was much indebted for valuable assistance, as also to Lieutenant-Colonel Little, Chief of the Staff, and to Lieutenant-Colonel Hills, C.B., R.E., Commanding Royal Engineers.

With a view to enhancing the value of the 6-inch survey, from a military point of view, Colonel Hills very kindly allowed Captain Haydon, R.E., and Lieutenant Carr Young, R.E., Field Engineers, to take up the examination of the field sheets as they were completed. The notes made by these officers are most valuable, and have been as far as possible embodied upon the map.

The fair sheets, five in number, have been drawn by Captain Hobday, Lieutenant Longe, and myself, and typed by two of the sub-surveyors of the Guzerat party: I should recommend their publication, both upon the 6-inch and 4-inch scales. The detail survey of the city, with the exception of the citadel, has been taken from the old map published by the Quartermaster General's Department in 1840, and the villages surveyed by the guides on the larger scale of 200 feet to the inch have been reduced and incorporated upon the fair sheets.

A triangulation chart upon the scale of 2 inches to the mile accompanies the map.

During the latter months of our occupation of Kandahar, an attempt was made to train men as explorers, chosen from natives of the district, and two "Saiads" were selected for the purpose. Lieutenant Talbot spent a considerable amount of trouble in the undertaking, and had been so far successful that I was enabled before leaving Kandahar to plot some fairly accurate route surveys taken by one of these men with a prismatic compass over portions of the district which had been already surveyed; but a second expedition, upon which the same man was afterwards sent into the Terin valley, was less satisfactory. The time was inopportune. The country north of the Kotal-i-Paj was in an unsettled state; it was already well known that the evacuation of Kandahar by the British troops was by no means a remote contingency, and men of the class most likely to be successful were not to be tempted even to undergo the necessary preliminary training without a handsome guarantee out of all proportion to the value of the work they were called upon to perform.

It is, however, to native explorers that we must look in future for an extension of our geographical knowledge beyond present limits, and there can be no question that men of the "Saiad" class are both willing to take service, and are permitted to travel unmolested throughout the greater portion of Upper Afghanistan. But the training must be a prolonged one, and I much question the value of rough route surveys, which are all that can be looked for if the explorer is turned loose after a short apprenticeship. Such men might be enlisted in the first instance as supernumeraries in the frontier surveys now in progress, and regularly trained as detail surveyors. Many would doubtless prove failures as explorers, but would do good work and pay their way with a party, and there would thus be gradually formed a nucleus of likely men upon whom to draw for the more difficult and delicate work of exploration. The ability shown by many of the cavalry troopers of the corps of guides in making eye sketches, &c., during the late campaign may be taken as a proof that success is attainable. Many of these men are natives of the districts where our information is still deficient, and upon completion of their service take their pensions and return to their houses. There still exist in these localities, and at comparatively short distances beyond our frontier, small tracts entirely unexplored, routes but little known, and larger areas of partially surveyed country, the detail upon which might be very much improved.

The subject is, however, one that is engrossing the attention of other officers of the Department, and I would merely wish to endorse views that have been partially supported by practical experience, notably during the late Waziri expedition.

Memorandum on survey operations in and around Gilgit for season 1880-81, by Lieut. Colonel H. C. B. Tanner, S.C., *Deputy Superintendent, 3rd Grade,—dated Dehra Dun, the 31st January 1881.*

The survey of Gilgit was completed during the past summer by Ahmad Ali Khan, Sub-Surveyor, who, besides, continued the map of the Astor country towards the chief passes which lead into the Indus Valley on the one hand and into Kashmir on the other.

All the passes which lead out of the Gilgit valley into Darel, Chilás, Hodar, Kingar, &c., on the Indus, have now been fixed by actual survey, and the two most important ones which have been of late years used by Kashmir troops have been visited. On the Astor side the Mázeno Pass has been surveyed, and when the remaining passes on the Kishenganga-Chilás water-shed shall have been visited by a surveyor, it is hoped that we shall be in possession of a very fair sketch map of that portion of Dárdistán which lies on both banks of the Indus between Bunji and the mouth of the Darel stream—a direct distance of some 60 miles. This tract contains the valleys of Darel, Hodar, Khánbari, Kingar, Gies, and the settlement of Gor on the right bank, with Chilás, Thaka (Thak), Bunar and some uninhabited valleys on the left. The route survey of the Mulla will give detail which, when intelligently fitted on to this sketch of topography, will leave little to be desired in point of completeness; this fitting on will be by no means a difficult task, for both surveys agree remarkably well in the general course of the Indus for nearly 80 miles.

The Chonchar Pass is of some importance, for it is the only route practicable for horses between Gilgit and Darel. The route is up the wild valley of Kergah, which for nearly one day's march is almost destitute of vegetation, but afterwards passes through a beautiful Kashmir-like tract, with green sward, and forests of Pinus, Excelsa, and Abies Smithiana, and dense willow groves lining the stream; above this is grass country, and at the head of the valley, where vegetation ceases, the rugged hill sides and the path itself are strewn with piles of splintered rocks. From the summit of the pass, which is about 14,000 feet, the rough pathway leads down into the Khánbari Valley, which has to be crossed near its head. The Bárigáh Pass has then to be surmounted, after which a long descent leads to Yachut (Yahtut), the first village of the Darel group. It was at the head of the Kergáh Valley, somewhere near the Chonchar Pass, that in September 1866 one column of the Kashmir army, on its return from an expedition against Darel, was at night overtaken and almost overwhelmed by a sudden and unseasonable snow storm, in which a number of sepoys and coolies perished, and which caused the destruction of the flocks and herds of the Darelis, which the victorious Dogras were bringing back with them in triumph to Gilgit.

The second route to Darel is *viâ* the Singal Valley, at the head of which stands the Dodargali Pass, from which the head waters of the Darel Valley descend. The road is difficult. In the expedition above referred to, one column of the Kashmir army was sent from Gilgit by this route, but it did not reach Darel until too late to co-operate with the other column. The Dodargali is about 14,000 feet.

The minor passes which connect the head of the Sai with the heads of the Kingar and Hodar Valleys have been fixed: also, the Khánbari Pass between the valley of that name and Singal; and, lastly, the unimportant pass which leads from the head of the Dárnot Valley to the Forts of Gor. With the exception of the latter, which is about 12,000, they are all about 14,000 feet above the sea, and are closed for a considerable time in winter and spring.

The Mázeno and Tosho Passes are situated on the Astor and Bunar (Bundar) water-shed at the head of the wild valley of Rupal. They are used only by mountaineers on foot, and that with difficulty, and then only during a short period of the year, for they attain an altitude of 17,000 feet. In former times the raiders from Chilás used to come by this route to harry the Astor villages. From the village of Rupal, which is situated at the very foot of Nanga Parbat (Dia Mir), the route first lies over an ice field about 2 miles long, which is said to have been precipitated from the upper slopes of Nanga Parbat by an earthquake about 20 years before the damming up of the Indus near Gor on the other side of the mountain. Though this immense mass of ice has been for more than half a century exposed to the heats of summer without being fed by any glacier, yet it is still of great thickness, and it seems in a fair way to last a century longer.

Leaving this field of ice the tract lies sometimes on, and sometimes on one side of, a glacier for about 12 miles, when the summit of Mázeno is reached. Tosho lies 2 miles to the westward, and the two routes to Bunar joina few miles down the valley of that name on the Indus side.

The Mázeno Pass is situated in the midst of what is perhaps the grandest scenery of Kashmir. From the summit of the adjacent ridge the view embraces the countless ranges which enclose the whole of Dardistan, extending to the grand peaks of Terich Mir, and to those of the Hindu Kush beyond Chitral, while close at hand tower rugged and precipitous snow mountains of over 20,000 feet. Below, at a great depth, the minor acclivities which rise up from the arid banks of the Indus may be descried through the haze, but from the pass itself the river cannot be seen, numerous spurs from Nanga Parbat intervening.

The survey of the Astor Valley extends westwards to the village of Mir Malik in the valley of that name. There is a difficult track from this to Kashmir over the Shontar Pass to Kel and Loláb; and as the Maharajah of Kashmir is making what he thinks is an easy road by this route which is to lead to Astor and Gilgit, a few words about it will not be out of place. I crossed over the pass at the end of September, and had great difficulty owing to the steepness of the glacier which commences at the very top on the west side and runs down about a mile. There was great danger at the top of slipping on the steep ice and being engulphed in one of the numerous crevasses which overspread the whole glacier, and form a net-work or labyrinth through which we found our way after much search. Below the glacier are piles of loosely packed boulders extending for some distance, and at the bottom of the Moraine I found the end of the new road hopelessly lost in the side of a steep ravine from which there was no practicable outlet. No permanent road can ever be made over this pass without being constructed for a long distance over a glacier full of deep crevasses and amidst the tottering fragments of rocks which form the live Moraine below it. Besides, the pass is too high (nearly 15,000 feet) to be used except during a few months in the year. I was told by the people of Mir Malik that avalanches are of constant occurrence, and that the lower parts of the pass are constantly swept by them. The new road which, as I have said, ends in the foot of the Moraine has been made through the Kel Matchal and Loláb Valley, and though it may be convenient for sportsmen, it can never be of any use as a means of communication with Gilgit. The superb scenery of the whole route from Matchil to the head of the valley baffles description. The survey of it will be undertaken during the present year, when the chief passes which connect the Indus Valley with Kashmir will also be examined and mapped, and we shall then have a reliable record of every pass marching with the boundary of British and Kashmir territory on the one side, and the country of the independent tribes of the Indus on the other, for a distance of 220 miles, that is to say (including Kághan) throughout its entire length, or from Gakuch, the last point in Gilgit, to Darband and Amb in Hazára.

Extract from the Narrative Report, dated 25th May 1881, of CAPTAIN A. W. BAIRD, R. E., *in charge Tidal and Leveling Operations.*

EVALUATION OF TIDAL CONSTANTS.

THE values of the several tidal constants which have been determined for various ports, from the harmonic analysis of all the observations which have been taken during the past year, will now be given.

The tidal constants are divided, as usual, into two groups—one composed of the short-period tides, the duration of which in no case exceeds 24 hours; the other of long-period tides, whose duration ranges from a fortnight to a year.

In the harmonic theory of the tides, the principal constituents of the short-period tides are represented by fictitious stars, moving in circular orbits at certain known velocities—the arguments of motion—in the plane of the Equator. They are usually indicated by the letters S, M, O, K, &c. Each of these is, in its turn, composed of a number of tidal constituents, also moving in circular orbits, but with different velocities, which are mutually related, those of the second and subsequent constituents being twice, thrice, or some integral multiple of the first. Their periods are determined in the following manner. When the revolution of the fictitious star is performed in, or about, 24 hours, the primary period is the one corresponding to the argument of motion of the star; when it is performed in, or about, 12 hours, the primary period corresponds to twice the argument of the motion of the star; the subsequent periods are fractions of the primary, corresponding to the multiples of the velocity. The tidal constituents after the first are sometimes called semi-diurnal, ter-diurnal, quarter-diurnal, and so on, and the smaller of these are usually called *Overtides.*

Every tidal constant is expressed numerically by two constants, *viz.*, R, and ϵ. R denotes the linear value of the amplitude, *viz.*, the semi-diameter of the orbit, which is equal to half the range between the highest and lowest levels of the constituents; ϵ denotes the angular value of the "epoch;" it may be defined to be the number of $\frac{1}{360}$ part of the period—or number of degrees of the orbit—which any tidal constituent has still to execute from the instant when the fictitious star crosses the meridian of the place of observation to the instant when the constituent reaches its maximum.

The constants R, and ϵ, of the tidal constituents, are respectively distinguished by the subscripts 1, 2, 3, representing the relations of their periods to that of the primary period.

Three only of the fictitious stars, viz., S, M, and K, have more than one constituent of sensible magnitude. The constituent which causes any fictitious star to produce its greatest effect on the sea-level is rarely the first, and more frequently the second. The greatest effect of any single star is invariably produced by R_2 of M; afterwards usually by R_2 of S, and R_1 of K, to the last of which the phenomenon of *Diurnal Inequality,* which is so marked a feature in Indian tides, is chiefly due. The first significant constituent of MS is of the fourth period, amplitude R_4.

The first constant in the table of constants for each port is A_0 which signifies the height of the mean level of the sea above the level corresponding to the zero of the gauge.

It may be here said, once for all, that the values of the linear quantities A and R throughout these tables are invariably expressed in English feet.

VALUES OF THE TIDAL CONSTANTS AT BOMBAY, 1879.

The following are the amplitudes and epochs deduced from the 1879 observations at Bombay:—

Short-period Tides.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ	ν	μ or 2 MS.
R_1	0·0830	0·0591	1·4747	0·7140	0·4000	0·0909	0·1518	0·0562	1·0194	.....	.....	.....
ϵ_1	184°·282	343°·194	127°·493	327°·057	312°·946	127°·436	338°·814	183°·161	313°·266	.....	.....	.....
R_2	1·6343	3·9772	0·4506	.....	.....	.....	.....	.....	.....	0·0231	0·2412	0·1850
ϵ_2	2°·416	327°·301	337°·515	.....	.....	.....	.....	.....	.....	71·095	281·223	290·036
R_3	.....	0·0654	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	.....	25·019	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_4	0·0129	0·1250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
					.....	R.	T.	MS.	2 SM.			
ϵ_4	235·446	322·697	.....	.....	R_2	0·0455	0·0856	.....	0·0248	.....	.....	.....
R_5	0·0039	0·0136	.....	.....	ϵ_2	41°·464	124°·913	.....	126°·606	.....	.....	.....
ϵ_5	178·531	104·250	.....	.....	R_4	.....	.....	0·1362	.....	.....	.....	.....
R_6	0·0015	0·0037	.....	.....	ϵ_4	.....	.....	28°·065	.....	.....	.....	.....
ϵ_6	195·945	338·975	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

		R.	ϵ.
Lunar monthly	tide	0·046	355°·462
Lunar fortnightly	„	0·066	347°·494
Luni-solar „	„	0·016	289°·407
Solar annual	„	0·137	329°·578
Solar semi-annual	„	0·124	223°·279

The value of (A_0) the mean level of the sea is lower than that obtained in 1878, being 10·184 feet against 10·265, but the 1879 value is very nearly a mean between the values obtained in 1876 and 1878.

The amplitude of the main lunar tide (R_2 of M) is higher than was found either in 1876 or 1878, being 3·977 feet. The same remark applies to the main solar tide. The epochs of both the main tides do not differ by more than 5 minutes from that obtained in either of the two previous years.

The proportion of the main solar to the main lunar tide (R_2 of S), to (R_2 of M) agrees well with that formerly obtained, and is a little less than theory would assign, being 0·411 against 0·476 (the theoretical value).

The proportion of the smaller component (L) of the lunar elliptic tide is slightly less than that obtained in 1878, and may be said to be exactly half the theoretical value, but for the larger component (N) the proportion agrees well with what was obtained in 1878, and is more than 25 per cent. greater than the theoretical proportion.

The perturbation tides do not materially differ, in their proportions to the main tide, from what was obtained in 1878.

With regard to the solar elliptic tides, the smaller one (R) would appear to be three times too great, while the larger component (T) is slightly less in its proportion to the main tide, than the theoretical value.

The proportion of the luni-solar declinational semi-diurnal tide is less than the theoretical (being 0·113 against 0·127), while in each of the two former years (whose observations have been deduced), the theoretical proportion was exceeded.

Referring to the diurnal tides, the whole agree well with what was found in 1876 and 1878, the principal one (R_1 of K) being 37 per cent. of the main tide, while in 1876 the proportion obtained was about 40 per cent., and in 1878, 39 per cent.

The lunar and solar overtides at Bombay may be said to be insignificant, with the exception of the lunar quarter-diurnal, which is about 3 per cent. of the main tide.

Regarding the long-period tides, the solar annual tide is about double what was obtained in 1876, and rather more than half what was obtained in 1878, being 0·137 of the main tide; its epoch agrees tolerably closely with the value obtained in 1876, and would show the maximum effect as being due about the 15th February, while in 1878 the date of maximum effect was shown to be about the middle of July.

With reference to the solar semi-annual tide, the amplitude obtained in 1879 is about the mean of the two former values for 1876 and 1878; its epoch too is approximately a mean between the epochs of the two former years.

There is nothing remarkable in the proportions obtained for the lunar monthly and lunar fortnightly tides, as compared with the values obtained in 1876 and 1878, but for the luni-solar fortnightly, the value obtained in 1879 is only half of the 1876 value, and less than one-third of that obtained in 1878; its epoch, too, is very divergent from the value obtained in either of the former years.

VALUES OF THE TIDAL CONSTANTS AT BEYPORE, 1879-80.

The following are the amplitudes and epochs deduced from the observations at Beypore for 1879-80 :—

Short-period Tides.

	S.	M.	O.	K.	P.	J.	Q.	L.	N.	λ	υ	μ or 2 M. S.	R.	T.
R_1	0·0930	0·0334	0·3544	0·7112	0·1882	0·0490	0·0934	.....	.....	.....	.....	.....	.....	.....
ϵ_1	206°·719	250°·118	236°·993	134°·818	326°·068	121°·773	356°·105	.....	.....	.....	.....	.....	.....	.....
R_2	0·3100	0·8995	.....	0·0835	.....	.....	.....	0·0461	0·1884	0·0122	0·0407	0·0199	0·0172	0·0432
ϵ_2	19°·364	327°·615	.....	345°·379	.....	.....	.....	159°·427	306°·889	179°·012	18°·073	345°·007	264°·045	116°·413
R_3	.....	0·0096	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	.....	180°·404	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	MS.	2 SM.	.....	.....	.....	.....	.....	.....
R_4	0·0030	0·0145	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_4	118°·301	31°·556	.....	.....	.....	R_5	.....	0·0037	.....	.....	.....	.....	.....	.....
R_6	0·0041	0·0038	.....	.....	.....	ϵ_5	.....	220°·619	.....	.....	.....	.....	.....	.....
ϵ_6	344°·058	107°·778	.....	.....	.....	R_4	0·0041	.....	.....	.....	.....	.....	.....	.....
R_6	0·0003	0·0100	.....	.....	.....	ϵ_4	77·976	.....	.....	.....	.....	.....	.....	.....
ϵ_6	251°·565	121°·547	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

	R.	ε.
Lunar monthly tide	0·071	85°·421
Lunar fortnightly „	0·095	356°·026
Luni-solar „ „	0·037	168°·961
Solar annual „	0·344	315°·681
Solar semi-annual „	0·252	181°·295

The value of the mean level of the sea (A_0) from the 1879-80 observations was found to be 5·392 feet above the zero of the gauge, being 0·007 feet higher than that obtained last year.

The main lunar tide (R_2 of M.) for Beypore for 1879-80 is almost of the same magnitude as that obtained from the 1878-79 observations. Its epoch also agrees well with that obtained for 1878-79.

The amplitude of the main solar tide (R_2 of S.) is slightly less than that obtained for 1878-79, but its epoch is almost precisely the same.

The proportion between the two main tides (R_2 of M. and R_2 of S.) is still less than was found for 1878-79, regarding which, it was remarked that the value was considerably less than the theoretical proportion, and, except at Okha and Hanstal, this proportion between the two main tides is the least yet obtained for any port in India.

The smaller lunar elliptic semi-diurnal tide (L) has more than double the value obtained for 1878-79, which agreed fairly well with the theoretical proportion. The proportion of the larger component (N) to the main tide, agrees well with what was found for 1878-79; and although a little greater than the theoretical proportion, it is here more accordant with it than at the northern ports of the Bombay Presidency; while at the southern ports on the east coast, the proportion obtained is generally less than that assigned by theory. The proportions of these two lunar elliptic semi-diurnal tides at Beypore and Vizagapatam are similar.

The two evectional tides (λ. and ν.) have greater magnitudes than was found in 1878-79, and both exceed the theoretical proportions.

With regard to the variational tide (μ.), the proportion to the main tide from the 1879-80 observations is exactly the same as the theoretical value.

The solar elliptic semi-diurnal tides (R and T) have been for the first time deduced; the former has a value five times as great as the theoretical, and the latter about twice the theoretical value.

With regard to the luni-solar declinational semi-diurnal tide (R_2 of K), the proportion to the main tide is slightly greater than was found in 1878-79, but is still considerably less than the theoretical.

Referring to the diurnal tides, the proportion of the most important one (R of K) to the main tide is less than was found in 1878-79, but is still exceedingly high, and, as was said last year, approaches closely to the value obtained at Aden, where the amplitude of this tide is unprecedentedly high.

The proportions of the other diurnal tides are all about from 20 to 30 per cent. higher than at Karwar, where again the proportions were all greater than at Bombay and Kurrachee. With the exception of the solar diurnal tide (which is nearly four times as great as in 1878-79), the proportions to the main tide do not materially differ from the 1878-79 observations.

There is nothing remarkable about the lunar and solar overtides, with the exception of the lunar quarter diurnal, which is again found to be greater in its proportion to the main tide than is generally the case.

With reference to the long-period tides at Beypore, the lunar monthly tide bears the same proportion to the main tide, as in 1878-79, which was remarked to be higher than is generally found at Indian ports; the lunar fortnightly tide is less in its proportion to the main tide than for 1878-79, but is still from two to three times as great as at other Indian ports. The luni-solar fortnightly tide has only about one-half the value obtained in 1878-79; but still this tide at Beypore greatly exceeds in its proportion to the main tide the value found at other ports. Regarding the solar annual tide, the proportion to the main tide is a little greater than was found for 1878-79. This tide would appear to have its maximum effect (as regards the west coast of India) at Beypore, as not only is its proportion to the main tide greater than at any other port on the west coast, but its amplitude exceeds that found at any port on that coast. The epoch of this tide agrees very well with that obtained for 1878-79, its maximum occurring only four days later.

The proportion of the solar semi-annual to the main tide is nearly double what was found for 1878-79, and is thus very much greater than is generally found on the west coast of India.

It is remarkable that at Beypore, as at Paumben, the solar annual tide has increased in its proportion to the main tide about 16 per cent. over the 1878-79 values, and the solar semi-annual tide has also increased in its proportion to the main tide very greatly in 1879-80 to what was found in 1878-79. The epoch of the solar semi-annual tide would appear to occur about 22 days earlier from the 1879-80 observations than from the observations of 1878-79.

VALUES OF THE TIDAL CONSTANTS AT PAUMBEN, 1879-80.

The following shows the amplitude and epochs deduced from the 1879-80 observations:—

Short-period Tides.

	S.	*M.*	*O.*	*K.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ.	*υ.*	$\frac{\mu}{2\,MS.}$	*E.*	*T.*
R_1	0·0497	0·0103	0·1192	0·2041	0·1065	0·0130	0·0221	.....	.....	.....	.....	.....	.....	.....
ϵ_1	130°·891	233°·365	324°·782	126°·634	316°·849	122 ·441	18° 365	.....	.....	.....	.....	.....	.....	.....
R_2	0 3754	0°5·07	.....	0·1177	.....	.....	.....	0·0322	0·0864	0·0230	0·0341	0·0098	0·0122	0·0389
ϵ_2	92°·305	44°·046	.....	74°·901	.....	.....	.....	230°·486	28°·161	201°·957	47°·164	93°·841	233°·625	183°·262
E_2	.....	0·0158	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
τ_2	.....	165°·261	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
				.....	*MN.*	.....	2 *M.*							
R_3	0·0010	0·0157	.....	R_4	0·0167	R_2^2	0·0076	.....	.....	.....	.....	.....	.....	.....
ϵ_3	191°·310	186°·280	.....	ϵ_4	291°·818	ϵ_2	340°·837	.....	.....	.....	.....	.....	.....	.....
R_4	0·0014	0·0112	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_4	167°·905	43°·979	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R_5	0·0046	0·0042	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_5	254°·745	339°·221	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

	R.	ε.
Lunar monthly tides	0·052	57°·516
Lunar fortnightly „	0·045	333°·312
Luni-solar „ „	0·013	211°·000
Solar annual „	0·138	318°·050
Solar semi-annual „	0·178	109°·882

The value of (A_0) mean level of the sea is slightly higher than in the preceding year being 2·707 feet above zero against 2·666 feet for 1878-79.

The main lunar tide (R_2 of M.) for 1879-80 at Paumben is almost of the same magnitude as that deduced from the observations of the previous year, and this remark applies also to the main solar tide.

The proportions between the two main tides (R_2 of M) and (R_2 of S) is necessarily, from the above statement, almost the same as was found in 1878-79, being 0·645 against 0·652; this proportion is much greater than the theoretical proportion (0·476), and, as was remarked in the preface to the last year's observations, is the highest proportion yet obtained except at Tuticorin.

The proportion of the smaller elliptic semi-diurnal tide (L) is exactly double what theory would assign, while in the last year's observations, it was only 33 per cent. greater, and, except at Tuticorin and Hanstal, the proportion of this tide on the west coast of India does not generally greatly exceed the theoretical proportion, while in the Hooghly and at Rangoon, the proportion of this tide to the main tide is from two to three times as great as the theoretical.

With regard to the greater co-efficient of the lunar elliptic tide (N), the proportion to the main tide at Paumben is again much less than the theoretical, but it is a little greater in magnitude than was found from the observations of 1878-79.

In the moon's perturbation tides, the proportion of the evectional tide (λ) to the main tide is still greater than was found in 1878-79, and this remark applies also to the other evectional tide (υ) which is twice as great in magnitude as the 1878-79 value.

The variational semi-diurnal tide (μ) is three times as great in magnitude as the value obtained in 1878-79, and approaches closely (in its proportion to the main tide) to the theoretical value.

The solar elliptic semi-diurnal tides (R) and (T) have been deduced, for the first time, for Paumben (2 years' observations being necessary). With regard to the larger component (T) the proportion to the main tide is more than double the theoretical value, while for the smaller (R) it is nearly five times too great; these proportions do not materially differ from what was obtained at Beypore.

The luni-solar declinational semi-diurnal tide (R_2 of K) is almost precisely the same as was found for 1878-79, which was higher in proportion to the main tide than was usually found at Indian ports.

The diurnal tides deduced from the 1879-80 observations do not greatly differ in these values from those obtained for 1878-79. The most important of these (R_1 of K) is slightly smaller than obtains at some places, but is very similar in its proportion to the mean of the values found at Kurrachee.

With regard to the lunar and solar overtides, the same remark which was made for the 1878-79 values, applies here, *viz.*, that R_3 and R_4 of M are those of any importance, the lunar quarter-diurnal R_4 of M is slightly less in its proportion to the main tide than was found last year, while the ter-diurnal tide is exactly the same in proportion to the main tide as was found in 1878-79.

With reference to the long-period tides at Paumben, the proportions of all are greater than we usually find at ports on the west coast of India; the solar annual is very nearly one quarter of the main tide (this is a higher proportion than last year), the solar semi-annual tide at Paumben is exactly 30 per cent. of the main tide, and this is the only case on record where this tide exceeds the solar annual tide; the proportion for 1879-80 considerably exceeds that obtained for 1878-79, being 0·306 of the main tide against 0·239 for 1878-79. Its maxima occur about 20 days after the dates found for 1878-79, being about the middle of June and middle of December, but still this bears out the idea that the tide is entirely due to wind, having its maxima about the beginning of the south-west and north-east monsoons. The other long-period tides do not materially differ in their values to what was obtained in 1878-79.

VALUES OF THE TIDAL CONSTANTS AT MADRAS, 1880-81.

The following shows the amplitudes and epochs deduced from the 1880-81 observations at Madras:—

Short-period Tides.

The value of (A°) mean line of sea = 2·251 feet above zero of gauge.

	S.	M.	O.	K.	P.	J.	Q.	L.	N.	λ.	ν.	μ² or 2 M.S.	M.S.	2 S. M
R_1 ...	0·0369	0·0201	0·0067	0·3012	0·0925	0·0302	0·0044	.....	.....	.....	.....	. ....	.. ..	..
ε_1 ...	80°·487	170°·885	247°·214	60°·915	250°·638	64°·190	60°·508	.....	.....	.....	... ..	.. ..	.... .	...
R_2 ...	0·4372	1·0438	.....	0·1258	.....	.....	.....	0·0458	0·2439	0·0267	0·0527	0·0462	.. .	0·019
ε_2 ...	277°·359	217°·296	.....	259°·975	.....	.....	.....	93°·104	240°·844	185°·732	206°·452	178°·407	.. ..	236°·275
R_3 ...	.....	0·0035	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	... .	..
ε_3 ...	.....	62°·243	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
R_4 ...	0·0022	0·0023	.....	.....	.....	.....	.....	.....	.....	...	.....	.. .	0·0030	...
ε_4 ...	97°·765	125°·388	.....	.....	.....	.....	.....	.....	.....	.....	.....	.. ..	174°·740	
R_6 ...	0·0018	0·0096	.....	.....	.....	.....	.....	.....	.....	.....	.. .	.....	.....	
ε_6 ...	60°·642	154°·403	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	. ..	...
R_8 ...	0·0011	0·0017	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
ε_8 ...	131°·186	322°·576	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long-period Tides.

	R.	ε.
Lunar monthly tide	0·040	40°·648
Lunar fortnightly „	0·032	341°·052
Luni-solar „ „	0·001	86°·184
Solar annual „	0·372	200°·563
Solar semi-annual „	0·275	119°·832

The main lunar tide (R_2 of M) has its amplitude nearly twice as great at Madras as at Paumben, but is only two-thirds of the magnitude which was found at Vizagapatam both in 1879-80 and 1880-81.

The main solar tide (R_2 of S) = 0·437, is greater than at Paumben, and less than the value deduced for Vizagapatam; in fact it is slightly less than the mean of the values of the main solar tide at those two places.

The proportion between the two main tides (R_2 of M) and (R_2 of S) = 0·419, is less than the equilibrium theoretical value 0·476, and this is rather remarkable, because at Vizagapatam the proportion almost coincided with the theoretical proportion, while at Paumben (on the other side of Madras from Vizagapatam) the proportion was about 20 per cent. greater than the theoretical proportion.

The proportions between each of the two lunar elliptic tides (L and N) and the main tide are greater than the theoretical proportions: for the lesser (L), the proportion is 0·044 against 0·027; this is a little higher than either of the proportions obtained for the two years' observations which have been reduced at Vizagapatam, and is about a mean between the two values of the proportions found at Paumben for 1878-79 and 1879-80.

Regarding the larger elliptic semi-diurnal tide (N), the proportion (·235) to the main tide is very similar to that obtained at Vizagapatam for 1879-80, but is very much greater than that obtained at Paumben for either of the two years which have been reduced; the proportion, however, is very similar to the mean of all the values found at Kurrachee, and does not differ materially from that found at Bombay and Kárwár.

With reference to the moon's perturbation tides (λ, μ, υ), the proportions to the main tide are all much greater than theory would assign; for the smaller of the two evectional tides (λ), the proportion is about three times too great, and for the greater of these two tides (υ), it is about 30 per cent. too great: at Vizagapatam, the proportion of this latter tide for 1879-80 was found to be about double the theoretical value; while for 1880-81, the proportion agrees fairly well with the theoretical. Again, at Paumben for 1878-79, the proportion was somewhat less than the theoretical, while for 1879-80 it was much in excess. For the variational tide, the proportion at Madras is exactly double the theoretical value, while at Vizagapatam for the two years 1879-80 and 1880-81, the proportion was very slightly less than what theory would give; again, at Paumben, the proportion for 1878-79 was very much less, and for 1879-80 slightly less than we obtain by theory.

The luni-solar declinational semi-diurnal tide (R_2 of K) agrees well at Madras, in its proportion to the main tide, with the theoretical value; and this was found to be the same at Vizagapatam, if we take the mean of the two years' observations reduced, while at Paumben the proportion obtained from the two years' observations is much in excess of the theoretical value.

With reference to the luni-solar compound semi-diurnal tide (2 SM), the proportion obtained between it and the main tide is slightly greater than was found at Paumben, and very much more so than was found at Vizagapatam, and may be said to be about double what was found at Bombay or Kurrachee.

As at Vizagapatam, one of the main features of the Madras tides is the very small proportion which the diurnal tides bear to the main lunar tide. Beginning with the luni-solar declinational diurnal tide (R_1 of K) as being the most important, we find that its proportion to the main tide is only about one-half what was found at Kurrachee, about one-third what was found at Karwar, 30 per cent. less than what was found at Bombay, and from one-third to one-fourth what was found at Beypore and Aden; but although rather more than one-half the proportion at Paumben, it agrees fairly well with that found at Vizagapatam.

The proportion of the solar diurnal tide (R_1 of S) at Madras, to the main tide, is very similar to what was found at Kurrachee, and agrees well with that obtained for 1880-81 at Vizagapatam, but is less than one-half of the mean of the proportions found at Paumben.

With reference to the solar-diurnal declinational tide (P), the proportion to the main tide is about one-half of that obtained at Kurrachee, 12 per cent. less than at Bombay, and about one-half of the proportion at Karwar or Beypore; but it is slightly greater than the Vizagapatam proportion, although only one-half of that obtained at Paumben.

The lunar diurnal tide (R_1 of M) in proportion to the main tide is exactly the same as the mean of the two years' proportions at Vizagapatam, and it agrees with the proportion obtained for 1879-80 at Paumben, although that proportion was only one-half of what was found for 1878-79 at the latter port.

With reference to the lunar declinational diurnal tide (O), the proportion to the main tide is only about one-third of what was found at Kurrachee and Karwar, one-half of what was found at Bombay, and from one-fourth to one-fifth of the proportions obtaining at Beypore and Aden.

Regarding the elliptic diurnal tide (J), its proportion to the main tide is at Madras greater than was found at Vizagapatam or Paumben, but is much less than is found at Beypore or Karwar, and is somewhat less than the Kurrachee or Bombay proportions. The other elliptic diurnal tide (Q) is insignificant at Madras, and this was also found to be the case at Vizagapatam.

The lunar and solar overtides at Madras are also insignificant.

But the most remarkable feature at Madras is the exceedingly high value of the solar annual and semi-annual tides in their proportion to the main tide. The same phenomenon was observed in the Vizagapatam tides. The value of the amplitude of the solar annual tide at Madras is 0·372 of a foot, and of the solar semi-annual tide the amplitude is 0·275 of a foot; and the maximum effect of these tides is felt about September or October, so that at Madras, if a mean level of the sea was deduced from tidal observations taken for one complete lunation in October of any year, it would be at a higher level by 1 foot 4 inches than what would be obtained from tidal observations taken in March and April. This is a most important feature, and it would appear to hold good, in a greater or less degree, along the whole of the east coast of India; for at Vizagapatam the effect of the solar annual and semi-annual tides is to raise the general level of the sea between the months of July and December by nearly 2 feet over the level between the months of January and June. It must be remembered that the total rise and fall of the tide at Madras and Vizagapatam is small, and therefore the effect of these two long-period tides is all the more apparent.

The proportion between the solar annual tide and the main tide at Madras is not so great as at Vizagapatam, being 0·356 against 0·490, but it is about 40 per cent. greater than the proportion at Paumben, and about six times as great as the proportion found at Kurrachee. This tide is also strongly felt at Beypore, where the proportion is similar to that found at Madras. The epoch of the solar annual tide occurs about the beginning of October, or about 10 days later than at Vizagapatam, and is still further evidence of the tide being due to the south-west monsoon wind.

With reference to the solar semi-annual tide, the proportion to the main tide at Madras is about the same as was found at Paumben, which was the highest proportion hitherto deduced for any port; it exceeds the proportion at Vizagapatam by about 30 per cent. Its maxima occur about the 20th May and 20th November. The maximum effect due to the combination of the solar annual and semi-annual tides at Madras, would appear to be felt about the beginning of November, and this was observed when the tidal diagrams were being scrutinised.

With reference to the lunar monthly tide, the proportion to the main tide is much the same as was found at Kurrachee and Karwar, and about one-half of what was found at Beypore, and one-third of the Paumben value; still it is nearly three times as great as the proportion at Vizagapatam for 1879-80.

Regarding the lunar fortnightly tide, the proportion to the main tide is one-third of the value found at Paumben, and about 30 per cent. greater than the Vizagapatam value for 1879-80.

The luni-solar fortnightly tide at Madras is insignificant.

VALUES OF THE TIDAL CONSTANTS AT VIZAGAPATAM, 1880-81.

The following are the amplitudes and epochs deduced from the 1880-81 observations at Vizagapatam:—

Short-period Tide.

	S.	M.	K.	O.	P.	J.	Q.	L.	N.	λ	υ	$\frac{\mu}{2MS.}$
R_1	0·0470	0·0219	0·3730	0·1452	0·1038	0·0279	0·0067	...	...	...	...	...
ϵ_1	76°·969	190°·257	69°·395	252°·592	256°·067	73°·117	197°·502	...	...	...	...	...
R_2	0·6589	1·4559	0·1634	...	...	...	...	0·0539	0·2985	0·0189	0·0551	0·0255
ϵ_2	285°·863	251°·303	256°·458	...	...	...	..	60°·268	247°·664	149°·644	196°·491	254°·604
R_3	...	0·0011	...	...	...	...	.	...	...	...	...	...
ϵ_3	...	204°·834	...	...	...	...	...	...	...	...		
						...	R	T	2SM	MS		
R_4	0·0065	0·0140	...	...	...	R_2	0·0153	0·0206	0·0097	...	...	...
ϵ_4	76°·608	326°·319	...	...	...	ϵ_2	230°·796	55°·344	294°·543	...	...	...
R_6	0·0011	0·0042	...	...	...	R_4	...	...	...	0·0095	...	...
ϵ_6	127°·875	171°·499	...	...	...	ϵ_4	...	...	...	17°·881	...	...
R_8	0·0013	0·0024	...	...	...	...	...	...	...	...	...	...
ϵ_8	102°·995	205°·614	...	...	...	...	...	...	...	...	...	...

Long-period tides.

	R.	ε.
Lunar monthly tide.	0·077	52°·542
Lunar fortnightly „	0·055	317°·543
Luni-solar „ „	0·021	15°·102
Solar annual „	0·833	173°·280
Solar semi-annual „	0·328	126°·021

The value (A_0) mean level of the sea=4·917 feet does not materially differ from that obtained in 1879-80, being 0·074 feet lower. It may be here mentioned that at Paumben, the mean level of the sea for 1879-80 was slightly higher than for 1878-79, thus the mean level at Vizagapatam and at Paumben would not appear to follow the same law as far as the tidal observations have yet shown.

With regard to the main lunar tide (R_2 of M), the amplitude from the 1880-81 observations is 0·05 less than that deduced for 1879-80, and for the mean solar tide the amplitude is also less than for 1879-80. The epochs of the two main tides occur in each case about 10 minutes after that obtained in 1879-80. The proportion between the two main tides (R_2 of S) and (R_2 of M) is very nearly the same as that for 1879-80, being 0·453 against 0·447, and this agrees better with the theoretical proportion 0·476.

The proportions of the two lunar elliptic tides (L) and (N) to the main tide are both slightly in excess of the theoretical, for the smaller of the two (L) it is 0·037 against 0·027, the theoretical value, and this is very similar to what was obtained last year; but for the larger component (N) the proportion (0·205) is much nearer the theoretical value (0·192) than was obtained from the 1879-80 observations (0·232).

With regard to the perturbation tides, the evectional (λ) and the variational (μ) agree well in their proportions to the main tide with what was obtained in 1879-80, the former being about double the theoretical proportion, and the latter slightly in defect of what theory would assign, with reference to the larger evectional tide (υ); the proportion to the main tide is almost precisely the same as the theoretical, while in 1879-80 the proportion found was double the theoretical.

Regarding the solar elliptic tides which have been deduced for the first time for Vizagapatam, the smaller one (R) is about two and a half times as great as the theoretical proportion, while the larger component (T) has only half the theoretical proportion.

The luni-solar declinational semi-diurnal tide has a somewhat less proportion to the main tide than theory would assign, while in 1879-80 the proportion was slightly too great: a mean between the two values would give a very fair approximation to the theoretical value.

Regarding the diurnal tides, the same remark applies as in the 1879-80 observations, *viz.*, that they are all about half what obtains at Bombay and Kurrachee, and generally on the west coast of India, and the *smallness of the diurnal tides is one of the main features* of the tides at Vizagapatam.

The proportion of the principal diurnal tide (R_1 of K) is about one-quarter of the main tide; and for 1880-81 the proportion is slightly less than for 1879-80. Now the proportion at Paumben to the main tide is more than twice as great as at Vizagapatam, while at Madras it was only about 3 per cent. greater than at Vizagapatam; and again, as we ascend the Bay of Bengal, we find that the proportions obtained in the Hooghly were only about half the values at Vizagapatam.

Regarding the remaining diurnal tides, the proportions do not materially differ in 1880-81 from what was found in 1879-80, except perhaps the solar diurnal, which is about twice as large as was found last year, and thereby accords more in its proportion to the main tide with what holds good on the west coast of India.

The lunar and solar overtides are all small, and call for no special mention, except perhaps the quarter-diurnal tides, which are each about one per cent. of the main tide.

But, as was pointed out last year, the most remarkable feature of the Vizagapatam tides is the very high proportion of the solar annual tide, and for 1880-81 the proportion of this tide to the main tide is even much higher than what obtained in 1879-80, being actually 83 per cent. against 74 per cent. obtained last year. The epoch of this tide occurs about 17 days before the date obtained from the 1879-80 observations, and would give the maximum effect about the middle of September. The solar semi-annual tide has also a much higher proportion than that obtained in 1879-80, being, as nearly as possible, one-third of the main tide, its epoch is, however, 19 days later than was found from the 1879-80 observations.

Regarding the lunar monthly and lunar fortnightly tides, the former is more than three times as great as the value obtained in 1879-80, and the latter 50 per cent. greater; the luni-solar fortnightly tide has an amplitude of less than one-third of the value obtained in 1879-80.

VALUES OF THE TIDAL CONSTANTS AT RANGOON, 1880-81.

The following shows the amplitudes and epochs deduced from the 1880-81 observations at Rangoon:—

Short-period Tides.

The value of (A_0) mean level of water=15·074 feet above zero of gauge.

	S.	M.	*O.*	*K.*	*P.*	*J.*	*Q.*	*L.*	*N.*	λ	υ	$\frac{\mu}{or}$ $2MS.$
R_1	0·1197	0·0520	0·2992	0·6875	0·1335	0·0508	0·0286	...	...	...	...	...
ϵ_1	140°·832	311°·507	310°·141	115°·815	331°·301	147°·155	289°·746	...	...	...	...	...
R_2	2·0092	5·5277	...	0·5523	...	...	...	0·4543	1·0431	0·2977	0·4782	0·4953
ϵ_2	169°·385	128°·344	...	150°·342	...	...	...	326°·812	115°·041	352°·012	92°·041	284°·473
$?_3$	...	0·0093	...	...	...	...	...	...	...	...	...	...
ϵ_3	...	235°·003	...	...	...	...	...	...	...	...	...	...
R_4	0·0755	0·3861	...	...	...	...	...					
						MS	2SM					
ϵ_4	262°·160	162°·421	...	...	R_2	...	0·1728	...	...	...	...	...
R_6	0·0114	0·2351	...	...	ϵ_2	...	48°·244	...	...	...	...	...
ϵ_6	41°·800	78°·452	...	...	R_4	0·3476	...	...	...	...	...	...
R_8	0·0058	0·0733	...	...	ϵ_4	205°·013	...	...	...	...	...	...
ϵ_8	118°·768	83°·407	...	...	...	...	...	...	...	...	...	...

Long-period tides.

	R.	ε.
Lunar monthly tide	0·294	20°·528
Lunar fortnightly „	0·180	12°·343
Luni-solar „ „	0·514	47°·630
Solar annual „	1·600	144°·057
Solar semi-annual „	0·193	305°·642

The amplitude of the main lunar tide (R_2 of M) at Rangoon is much larger than any yet deduced for any port in India, being over 5½ feet; while at Bombay, which has the largest range of any port on the west coast at which observations have been taken, it was under 4 feet; and in the Hooghly, at Diamond Harbour (where the amplitude is greater than at either Kidderpore or Fort Gloster), the value was only a little over 4½ feet. The same remark applies to the main solar tide; except that at Diamond Harbour, the amplitude is slightly greater than at Rangoon.

The proportion of the main solar to the main lunar tide (R_2 of S) to (R_2 of M) is 0·363; this is considerably less than the theoretical value 0·476. Now in the Hooghly, although the proportion between the two main tides was less than theory would assign, still it did not materially differ, and the proportion at Rangoon is, with the exception of Beypore and Okha, the lowest yet deduced.

The lunar elliptic semi-diurnal tides at Rangoon are somewhat peculiar; the lesser one (L) is three times as great as the theoretical value, while it has been usually found at other ports in India, with the exception of the Hooghly, that this tide generally agrees with the theoretical value. But the tides at Rangoon and in the Hooghly must of course bear a close resemblance to each other, and it was found at Diamond Harbour, Fort Gloster, and Kidderpore that this lunar elliptic semi-diurnal tide (L) was more than twice as great in proportion to the main tide as the theoretical value.

The larger component (N) of the lunar elliptic semi-diurnal tide agrees almost exactly with the theoretical value. In the Hooghly it was also found to agree fairly well, although a little smaller than theory would assign, while at every station on the west coast this tide may be said to have exceeded the theoretical proportion.

With reference to the lunar perturbation tides, the evectional (λ) is abnormally high in its proportion to the main tide at Rangoon, and here it resembles what was found at Fort Gloster and Kidderpore; while at Diamond Harbour, the proportion, although greater than theory would assign, did not very greatly differ from Madras, Kurrachee, or Paumben.

The proportion of the larger component (ν) of the evectional tide is more than double the theoretical; here too it closely resembles the Hooghly tides.

With regard to the variational tide (μ), the proportion to the main tide is four times greater than the theoretical; in the Hooghly it was found to be about three times too great, while at Kurrachee, Karwar, Beypore, and Vizagapatam, the proportion agreed fairly well with the theoretical; at Aden and Bombay it was about double the theoretical proportions, while at Paumben it was less than theory would assign.

The solar elliptic semi-diurnal tides have not been deduced, as two years' observations are required for their reduction.

The luni-solar declinational semi-diurnal tide is at Rangoon one-tenth of the main lunar tide: this proportion is about 25 per cent. less than theory would give, while at the ports in India, the theoretical proportion is generally exceeded, and even in the Hooghly, the proportion of this tide to the main tide is considerably higher than theory would assign.

The luni-solar compound semi-diurnal tide has a much larger proportion in Rangoon (0·031) to the main tide than is found at other stations in India, with the exception of Fort Gloster, where the proportion is the same as at Rangoon.

But one of the main features of the Rangoon tides is the small values of the diurnal tides; this is precisely the same as was found in the Hooghly, and it would appear that the diurnal inequality is not felt to such a great extent in a tidal river, as at a station on the sea-coast. Taking the luni-solar diurnal tide (as the most important) the proportion at Rangoon to the main tide is only about 12 per cent., while on the west coast of India it ranges from 40 to 80 per cent., and at Aden it actually reaches 90 per cent. of the main tide; and again in the Bay of Bengal at Paumben, Madras, and Vizagapatam, it ranges from 50 to 26 per cent. of the main tide. With regard to the other diurnal tides, the solar (R_1 of S) is about half the value (in proportion to the main tide) generally found in India, but agrees well with what was found in the Hooghly. The lunar (R_1 of M) has half the proportional value to the main tide that obtains at Madras, while, compared with the proportion on the west coast, it is insignificant.

The lunar diurnal and the lunar and solar elliptic diurnal tides are all insignificant at Rangoon in their proportions to the main tide. This was found to be the case in the Hooghly. The Lunar diurnal declinational tide (R_1 of O) is at Rangoon about 5 per cent. of the main tide, which also agrees with the values found in the Hooghly; but if we neglect Vizagapatam and Madras, it is only from one-quarter to one-tenth of the proportion which obtains at other ports in India.

With regard to the solar overtides, the quarter-diurnal is (as may be expected) very large, being about 4 per cent. of the main tide. Again, the lunar quarter-diurnal tide is 7 per cent. of the main tide. These proportions, though excessive in comparison to other ports in India, are only about one-half of what was found in the Hooghly. It is this term (R_4 of S and R_4 of M) that makes the whole resultant tide rise faster than it falls, as is generally observed in estuaries and other localities separated from the ocean by considerable spaces of shallow water.

With the exception of the overtide (R_6 of M) the other overtides are insignificant at Rangoon, but this tide (R_6 of M) is undoubtedly a genuine shallow-water tide, being the second harmonic (as it were overtone) of the main lunar tide, and its proportion to the main tide is 0·043 at Rangoon; this is higher than was found in the Hooghly, where the proportion was about 3 per cent. of the main tide.

With reference to the long-period tides, the *solar annual is by far the most important;* its amplitude is 1·60 feet, and its maximum occurs about the middle of August, which would point to its being due entirely to rainfall; its proportion to the main tide is not nearly so great as was found at Kidderpore or Fort Gloster, but it is higher than was obtained at Diamond Harbour, and this proportion, although less than obtains at Madras, Beypore, and Vizagapatam, is much greater than is found at other ports in India; but the very large value

of the main lunar tide at Rangoon marks the very high value of this solar annual tide, in making a proportion between them.

The proportions of the other long-period tides to the main tide do not call for any special mention, except perhaps the luni-solar fortnightly, which is a compound tide, and bears the same proportion to the main tide at Rangoon as it does at Diamond Harbour.

The tidal observations at Rangoon have not yet been sufficiently extended to enable the effects of rainfall to be eliminated, but it will in all probability be found that the amplitudes of the solar annual and semi-annual tides vary proportionately with the rainfall.

VALUES OF THE TIDAL CONSTANTS AT MOULMEIN, 1880-81.

The following are the amplitudes and epochs deduced from the 1880-81 observations at Moulmein :—

Short-period Tides.

	S.	M.	O.	K.	P.	J.	Q.	L.	N.	λ.	υ.	$\frac{\mu}{2\,MS.}$
R_1	0·0954	0·0383	0·2631	0·4586	0·1134	0·0393	0·0443	...	...	...	...	...
ϵ_1	145°·510	279°·781	324°·691	120°·629	331°·996	129°·182	333°·212	...	...	...	...	...
R_2	1·4001	3·8844	...	0·4165	...	...	...	0·2476	0·7248	0·1612	0·3138	0·3032
ϵ_2	148°·320	109°·751	...	132°·789	...	...	...	305°·569	95°·082	329°·859	99°·323	268°·149
R_3	...	0·0232	...	...	...	...	...	...	...	...	...	...
ϵ_3	...	270°·680	...	...	...	...	...	...	...	...	...	...
R_4	0·0682	0·9257	...	...	...	...	...	...	...	...	...	...
						R	T	MS	2SM	...	...	...
ϵ_4	230°·055	164°·619	...	...	R_2	...	...	...	0·1272	...	...	...
R_6	0·0057	0·1046	...	...	ϵ_2	...	...	...	39°·782	...	...	...
ϵ_6	177°·990	193°·784	...	...	R_4	...	...	0·7407	...	...	...	...
R_8	0·0019	0·0339	...	...	ϵ_4	...	...	207°·782	...	...	...	...
ϵ_8	164°·476	116°·931	...	...	...	...	...	...	...	...	...	...

Long-period Tides.

	R.	ε
Lunar monthly tide	0·408	2°·996
Lunar fortnightly „	0·297	18°·948
Luni-solar „ „	1·088	45°·383
Solar annual „	2·460	144°·563
Solar semi-annual „	0·563	282°·508

The value of (A_0) mean level of the water is 8·453 feet above the zero of the gauge.

The value of the amplitude of the main lunar tide (R_2 of M) at Moulmein from the 1880-81 observations is equal to 3·884 feet, which is about two-thirds of what was obtained at Rangoon. The amplitude of the main solar tide (R_2 of S) is 1·40 feet; this is also about two-thirds what was found at Rangoon.

The proportion of the main solar to the main lunar tide (R_2 of S to R_2 of M) is 0·360, which is almost precisely the same as was found at Rangoon, and is considerably less than the theoretical value (0·476), and the same remark applies at Moulmein regarding this proportion as was given for Rangoon.

The lunar elliptic semi-diurnal tides at Moulmein bear a close resemblance to those at Rangoon, the lesser one (L) is two and a half times as great in its proportion to the main tide as the theoretical value; while it has usually been found at ports in India (with the exception of the Hooghly) that this tide generally agrees in its proportion to the main tide with the theoretical value. Regarding the larger component (N) the proportion at Moulmein is almost precisely the same as the theoretical proportion to the main tide, *viz.*, 0·189 against 0·192, and this proportion is precisely the same as was found at Rangoon.

With reference to the lunar perturbation tides, the evectional tide (λ) is abnormally high in its proportion to the main tide, but not quite so much so as at Rangoon, being 0·041 at Moulmein against 0·054 at Rangoon, while the theoretical proportion is only 0·007. This proportion at Moulmein very nearly agrees with what was found at Fort Gloster in the Hooghly. The proportion of the larger component of the evectional tide (υ) is 0·081, or rather more than double the theoretical proportion to the main tide; here too the resemblance to the Rangoon tide is very marked. With regard to the variational tide (μ), the proportion to the main tide is almost four times greater than the theoretical; here also the resemblance to the Rangoon proportion is apparent.

The solar elliptic semi-diurnal tides (R and T) have not been deduced, two years' observations being required.

The luni-solar declinational semi-diurnal tide is at Moulmein slightly larger than at Rangoon, being 0·107 of the main tide, that is, about 20 per cent. less than the theoretical proportion (0·127); the luni-solar compound semi-diurnal tide is very much the same as at Rangoon in its proportion to the main tide, being 0·033 of the main tide against 0·031 at Rangoon.

Thus it may be said that all the semi-diurnal tides at Moulmein closely resemble those at Rangoon in their proportion to the main tide.

But one of the main features of the Moulmein tides is (as at Rangoon) the small values of the diurnal tides, and this is precisely the same as was found in the Hooghly. Taking the luni-solar diurnal tide—K—(as being most important), the proportion at Moulmein of this tide to the main tide is only about 12 per cent., while it generally ranges from 40 to 80 per cent. at open-coast stations.

With regard to the other diurnal tides, the solar (R_1 of S) has about one-half the proportion to the main tide of what is generally found at Indian ports; the lunar diurnal (R_1 of M) is almost insignificant at Moulmein; the remaining diurnal tides at Moulmein are all insignificant, with the exception of the declinational tide (R_1 of O) which is about 7 per cent. of the main tide.

With regard to the solar overtides, the only one of importance is the quarter diurnal, which is (as was expected) very high, being 5 per cent. of the main tide; this is even greater than at Rangoon, where it was 4 per cent., and was considered abnormally high.

Again, the lunar quarter diurnal tide is exceedingly high in its proportion to the main tide at Moulmein—in fact *the very high proportion of the lunar quarter diurnal tide may be considered the most remarkable feature of the Moulmein tides*—it is actually 24 per cent., or nearly one-fourth of the main tide. It is this term in combination with the solar quarter diurnal that makes the whole resultant tide rise faster than it falls,—a result which is graphically shown most distinctly in the Moulmein diagrams.

With the exception of the overtide (R_6 of M) the other overtides are insignificant, but this overtide (R_6 of M) is at Moulmein 3 per cent. of the main tide, which is a little less than was found at Rangoon, where it was 4 per cent., but agrees well with the proportion found in the Hooghly.

With reference to the long-period tides at Moulmein, the *solar annual is by far the most important;* its amplitude is actually 2·46 feet, and it has a proportion to the main tide of 0·633: this is abnormally high, for (with the exception of Kidderpore) the highest value of the proportion of this tide to the main tide was 0·572 at Vizagapatam in 1880-81: the maximum value of this tide occurs at Moulmein about the middle of August (as at Rangoon), which would point to its being entirely due to rainfall. The solar semi-annual tide at Moulmein has an amplitude of 0·56 of a foot; its times of maxima also occur about the middle of August, and middle of February, the former date corresponding with the time of maximum of the solar annual. The proportion of this tide to the main tide at Moulmein is 0·155, which is more than three times as great as the proportion at Rangoon, and is a little less than the proportion at Fort Gloster. The proportion of the lunar monthly tide to the main tide is twice as great at Moulmein as at Rangoon, being about 11 per cent. of the main tide; this is a higher proportion than was found at Fort Gloster or Kidderpore. The lunar fortnightly tide at Moulmein is also double the value found at Rangoon as regards its proportion to the main tide.

But the luni-solar fortnightly tide has actually three times the value (in proportion to the mean tide) of that at Rangoon; it is 28 per cent. of the main tide; this is by far the highest proportion yet obtained for this tide; for at Kidderpore, where it was considered abnormally high, the proportion to the main tide was only 24 per cent.

VALUES OF THE TIDAL CONSTANTS AT PORT BLAIR, 1880.

The following are the amplitudes and epochs deduced from the 1880 observations at Port Blair: —

Short Period Tides.

	S.	M.	O.	K.	P.	J.	Q.	L.	N.	λ.	ν.	μ or 2 MS.
R_1	0·0284	0·0184	0·1570	0·4103	0·1296	0·0386	0·0238	.....	.....	.....	.....	.....
ϵ_1	49°·421	173°·667	219°·706	47°·654	234°·374	33°·536	156°·868	.....	.....	.....	.....	.....
R_2	0·9658	2·0415	.....	0·2915	.....	.....	.....	0·0710	0·4129	0·0354	0·1481	0·0944
ϵ_2	315°·512	277°·080	.....	296°·193	.....	.....	.....	80°·166	270°·899	46°·877	292°·186	283°·905
R_3	.....	0·0044	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_3	.....	17°·171	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
						R.	T.	MS.	2 SM.			
R_4	0·0034	0·0028	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
ϵ_4	106°·858	163°·004	.....	.....	R_2	.....	.....	.....	.....	.....	.....	.....
R_5	0·0024	0·0039	.....	.....	ϵ_2	.....	.....	.....	0·0205	.....	.....	.....
ϵ_5	152°·354	335°·886	.....	.....	R_4	.....	.....	0·0037	150°·809	.....	.....	.....
R_6	0·0022	0·0030	.....	.....	ϵ_4	.....	.....	151°·173	.....	.....	.....	.....
ϵ_6	97°·765	10°·447	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Long Period Tides.

	R.	
Lunar monthly tide	0·020	12°·953
Lunar fortnightly „	0·059	332°·333
Luni-solar „ „	0·019	170°·447
Solar annual „	0·299	162°·504
Solar semi-annual „	0·106	165°·140

The value of (A_0) mean level of the sea is equal to 4·792 feet above the zero of the gauge.

The value of the amplitude of the main lunar tide is equal to 2·042 feet, which is very nearly double the value of this tide at Madras, and is 33 per cent. larger than the same tide at Vizagapatam. The main solar tide at Port Blair (R_2 of S) has an amplitude of 0·966 of a foot.

The proportion between the two main tides is as nearly as possible the same as the theoretical, being 0·473 against 0·476 the theoretical; and this is the closest approximation yet obtained to the theoretical value,—a result which might have been anticipated, as the ocean tide would certainly be more truly felt at Port Blair than at any other locality where tidal observations have yet been taken in India.

The proportion between each of the two lunar elliptic tides, and the main tide, agrees more nearly with the theoretical proportion than at any port whose observations have yet been analyzed; the lesser one (L) is 0·035 of the main tide against 0·027 (the theoretical value), while the larger component (N) is 0·202 of the main tide, the theoretical proportion being 0·192; thus it will be seen that both are slightly in excess of the theoretical proportions.

With regard to the moon's perturbation tides, they may be each said to be twice as great in their proportion to the main tide as theory would assign. These tides at Madras and Vizagapatam have proportions not very different from Port Blair.

The solar elliptic semi-diurnal tides have not been deduced, two years' observations being required.

The luni-solar declinational semi-diurnal tide, in its proportion to the main tide, is a little greater than the theoretical, being 0·143 against 0·127; while at Madras the proportion obtained very nearly agreed with the theoretical, and at Vizagapatam the mean of the two years' values may be said to coincide with the theoretical proportion to the main tide. The luni-solar compound semi-diurnal tide at Port Blair has a proportion to the main tide exactly the mean between the proportions found at Vizagapatam and Madras.

As at Vizagapatam and Madras *one of the main features of the Port Blair tides is the very small proportion which the diurnal tides bear to the main lunar tide.* Beginning with the largest—the luni-solar declinational diurnal tide (R_1 of K)—its proportion to the main tide is only 0·201, which is even less than was obtained at Madras or Vizagapatam, and is the least yet obtained for any station in India, with the exception of Rangoon, Moulmein and the Hooghly, all of which are some distance from the sea-coast. The proportion of the solar diurnal tide (R_1 of S) to the main tide is 0·014, which is about one-half of the proportion at Madras and Vizagapatam.

With reference to the solar declinational diurnal tide (P), the proportion to the main tide is only 0·064, which is about 25 per cent. less than the proportion at Madras and 16 per cent. less than the Vizagapatam proportion. The only other diurnal tide of importance is the lunar declinational diurnal (O), which is about 8 per cent. of the main tide at Port Blair; while at Vizagapatam it is 10 per cent., and at Madras 9 per cent. of the main tide.

As might be expected at Port Blair, the lunar and solar overtides are quite insignificant.

With regard to the long period tides, the lunar monthly is insignificant at Port Blair; the lunar fortnightly has a value of 3 per cent. of the main tide, which agrees well with what was found at Madras and Vizagapatam; the luni-solar fortnightly tide is insignificant at Port Blair. The solar annual tide at Port Blair is only 0·146 of the main tide, while at Madras it was 0·356 of the main tide, and at Vizagapatam its amplitude was more than half the main lunar tide, and again at Paumben the proportion of this long period tide to the main tide was about 0·225, so that the value at Port Blair is the least yet obtained in the Bay of Bengal. The epoch of this tide is 163,° or its time of maximum effect is about the beginning of September, that is, about ten days earlier than at Vizagapatam and about one month earlier than at Madras.

With regard to the solar semi-annual tide, the proportion to the main tide is 0·052, which is from one quarter to one-fifth of the proportion which obtained at Madras and Vizagapatam. The times of maximum effect of this tide are about the middle of June and middle of December.

ANALYSIS OF HOOGHLY TIDAL OBSERVATIONS TAKEN AT KIDDERPORE, (CALCUTTA) FORT GLOSTER, AND DIAMOND HARBOUR, 1873 TO 1878.

The observations on which the results obtained from these analyses depend, were taken by self-registering apparatus, and the performances of the instruments were supervised by various officers of the Irrigation Branch of the Bengal Public Works Department.

The great cyclone of October 1864 did a vast amount of damage to the low-lying tracts on both sides of the River Hooghly, especially at Hijili.

In 1868 the feasibility of affording protection to these tracts from similar irruptions seems to have first attracted the attention of the Bengal Government.

The Government of India acknowledged the very great importance of the question to the people of Lower Bengal, and suggested that the investigation of the subject be entrusted to a qualified officer, and named Mr. Leonard, C.E., but that gentleman being otherwise employed Colonel Tennant's services were placed at the disposal of the Bengal Government for the work.

In June 1870, Colonel Tennant submitted proposals for four self-acting tide-gauges and wooden piers to put them on, and these piers were shortly afterwards erected, pending the arrival of the gauges from England. The gauges arrived at Calcutta in October 1871.

Meanwhile Mr. Unwin relieved Colonel Tennant, who was required by Government for other duties.

The first gauge was set up at Kidderpore, about the middle of December 1871, the second at Fort Gloster on the 5th January, and a third at Diamond Harbour on the 10th January 1872; a fourth one was set up in the Russalpoor River in September 1872, but the pier was observed to be undermined and unsafe, and it was removed shortly afterwards.

As only four gauges, in a distance of 90 miles, were considered insufficient for the purpose of correctly determining the various tidal phenomena, such as the rate of progress, height at different places, &c., ten more stations at intermediate places were selected, at which personal observations during the day time were made for a period of twelve months.

It is only the results of the observations taken by the three self-registering tide-gauges that are here dealt with.

In July 1872 the fourth self-acting tide-gauge was set up at Noa-Serai, and this was working simultaneously with the three other self-registering tide-gauges until lately; but (as the observations themselves showed) this station was evidently much too far up the river to feel the true effects of the tidal action, so these observations have not been analyzed.

I visited the instrument working at Kidderpore in January 1879, and found it to consist of a small drum about 15 inches long and 24 inches in circumference (on which the diagram paper was rolled) driven by a good pendulum clock: one revolution was made in 24 hours; thus 1 inch represented 1 hour on the time-scale.

The record of the rise and fall of the tide was given by a pencil moving horizontally along two bars above the barrel; the motion given to the pencil emanated from a float about 9 inches diameter and 6 inches deep, working vertically in an iron cylinder or well, in direct connection (at its bottom) with the water outside. The float was suspended to a chain passing over a stud or spiked wheel (the links of the chain catching in the studs) and there was a counterpoise weight at the other end of the chain. This stud-wheel communicated motion to a scale of wheels, and eventually to a sheave, on which some thick silver cord was wound. A brass traveller working between the horizontal bars was fixed to the silver cord, and the traveller carried the pencil. To the other end of the "pencil traveller" a second silver cord was attached, and this again was wound on a "spring wheel," so that the pencil traveller was always kept firmly in position. By a simple arrangement the pencil could be set to any position of the diagram corresponding to any height required.

The working scale was very small, $\frac{1}{24}$.

The zero of reference was the sill of the Kidderpore Dock.

A graduated staff erected close to the dock gave the height of water above the sill, and the self-registering gauge was always set so that the pencil should indicate on the diagram the same value as that indicated by the water on the staff. Thus the staff was virtually the standard, and the correctness of the setting of the self-registering tide-gauge depended on the smoothness of the water on the surface, and the care of the clerk who set the instrument periodically.

The diagrams were changed once a week.

The clock was set, now and then, to agree as nearly as possible with Calcutta mean time, and the barrel adjusted by eye to agree with the clock.

Calcutta mean time was supposed to be kept at all three stations. No attempt was made to maintain one exact zero at each place throughout the period of the observations, and moreover no attempt was made to obtain an absolute determination of each zero: the arrangements for keeping the clocks to exact Calcutta time were also very imperfect. Thus the observations were not so reliable and exact as they might have been.

Nevertheless I felt confident that, on account of the great number of observations available (7 years' work,) the results obtained from their reduction must be of considerable importance. I also considered that if the co-efficients determined from their analysis gave fairly accordant results, the data so obtained would be of immediate use for the construction of tide-tables.

Tidal observations have just been started at Kidderpore, Diamond Harbour, and Saugor with first class instruments, working on the same system as obtains at other tidal stations; but data from these sources will not be available for some years after the present time.

Accordingly, in January 1879, I applied to the Irrigation Department for all the diagrams taken (up to date) by the three self-registering tide-gauges at Kidderpore, Fort Gloster, and Diamond Harbour, and through the courtesy of Mr. Levinge, the Chief Engineer for Bengal, I obtained the whole of these records.

The analyses of the observations were taken up soon afterwards, and the results obtained are, I submit, complete proof that my surmise was correct, *viz.*, that fairly good and tolerably

accordant values of the tidal co-efficients might be deduced from the observations, and I maintain that as the results can be put to practical use at once, the very great amount of labour which had to be undertaken has been amply justified.

The zero of the instruments, &c.

The whole of the diagrams had a blue line drawn horizontally across them, which is marked as "mean-sea level." On the Kidderpore diagrams this line is marked as 6·25 feet above zero, at Fort Gloster it is noted as 7·33 feet, and at Diamond Harbour as 6·48 feet above zero.

It would appear from the various papers (to which I have had access) regarding these tidal observations that this line, described as "mean-sea level," was the value of "mean level of sea at Kurachee," brought down by the leveling of the Great Trigonometrical Survey of India from Kurrachee to Calcutta, and found to be 6·25 feet above the sill of the Kidderpore Dock. The three tidal stations were connected (by the Irrigation Department) by leveling with the following results:—

6·25 feet above zero of the gauge at Kidderpore,
7·33 „ „ „ at Fort Gloster,
6·48 „ „ „ at Diamond Harbour,
} were all on the same level.

Thus it is obvious that, in order to make the values obtained for A_0 (the mean level of *the river, not* the "mean level of *the sea*"), at the three stations, comparable *inter se*, we must deduct (7·33—6·25) 1·08 feet from the Fort Gloster values, and (6·48—6·25) 0·23 foot from the Diamond Harbour values, so that all three should be referred to the datum of the sill of Kidderpore Dock, *i.e.*, 6·25 feet below the Great Trigonometrical Survey value of mean level of sea at Kurrachee.

Mean level of the river.

The values of the several tidal constants which have been determined will now be given (*vide* printed table).

Explanation of the tidal constants.

The first constant in the table is A_0, and it must be here understood to signify the "mean level of the river," and not the "mean level of the sea," as it usually does; *because the "mean level of the sea," cannot be determined from observations taken at such distances from the sea-coast, even if the observations were free from the influence of floods in a river, such as those on the Hooghly are entangled with.*

It may be here said, once for all, that the values of the linear quantities A and R throughout these tables are invariably expressed in English feet.

Variation in the values of the mean level of the river.

The values of A_0 vary about 1 foot at Kidderpore (10·975 in 1874-75 to 9·931 in 1877-78), about 6¼ inches at Fort Gloster (11·278 in 1874 to 10·731 in 1877), and about 9 inches at Diamond Harbour (9·790 in 1874-75 to 9·052 in 1877-78).

After correcting the mean values of A_0, to reduce them all to the same zero of reference, *viz.*, the level of the sill of the Kidderpore Dock, the results are:—

A_0 { Kidderpore, 10·489 feet above sill of Kidderpore Dock.
Fort Gloster, 9·966 „ „ „
Diamond Harbour, 9·183 „ „ „

Thus the *mean level of the river* is 0·783 foot, or about 9⅜ inches higher at Fort Gloster than at Diamond Harbour, and again 0·523 foot, or a little more than 6 inches higher at Kidderpore (Calcutta) than at Fort Gloster.

Short Period Tides.

It will be convenient to discuss the results, taking Diamond Harbour (being nearer the sea) for the standard.

The main lunar tide.

The amplitudes of the main lunar tide (R_2 of M) vary at Diamond Harbour very slightly, the greatest value being 4·826 (in 1874-75) against the least 4·550 (in 1876-77) or only 0·275 foot, *i.e.*, a little over 3 inches, which is very little more than the extreme variation in ten years at Kurrachee. This variation is much less in proportion to the magnitudes of the tides at the two places, the mean value of this tide being 4·70 feet at Diamond Harbour and about 2·45 feet at Kurrachee.

The amplitudes of the main lunar tide at Fort Gloster vary more than at Diamond Harbour, *viz.*, 3·42 feet in 1876 to 4·07 feet in 1873, *i.e.*, a difference of 0·65 foot or about 8 inches.

At Kidderpore the variation is also greater than at Diamond Harbour, but less than at Fort Gloster, *viz.*, from 2·94 feet in 1875-76 to 3·54 feet in 1873-74, or about 7 inches.

The results even of Fort Gloster, however, must be considered fairly accordant, and compare favourably with the variation in the amplitudes of this tide as deduced from the tidal observations mentioned in the British Association Reports.

The amplitude of the main lunar tide decreases as we ascend the river.

The amplitude of the main lunar tide would appear to decrease from Diamond Harbour as we ascend the river: taking the means, we get Diamond Harbour 4·698, Fort Gloster 3·811, Kidderpore 3·318,—a result precisely the opposite of what was observed in the Gulf of Cutch.

Epochs of the main lunar tide.

The epochs of the main lunar tide vary considerably: at Diamond Harbour the variation is about 8°, at Fort Gloster 25°, and at Kidderpore about 28°. The variation at Diamond Harbour is a little more than the greatest variation yet noticed at Kurrachee; the variations at the other two stations are excessive; but if the results of the 1875 observations were not included, the differences between the maxima

and minima values of the epochs of this tide would be reduced to 13° at Fort Gloster, and to 17° at Kidderpore.

I attribute the large discrepancy in 1875 to clock error, and am of opinion that during the year in question, the instruments must have been even more carelessly attended to as regards time than they usually were.

The epochs of the main lunar tide, taking the mean of all the results, would give about 338° for Diamond Harbour, 30° for Fort Gloster, and 45° for Kidderpore; *i. e.*, the crest of this tide would reach Fort Gloster about 1 hour and 44 minutes after Diamond Harbour, and Kidderpore 2¼ hours after Diamond Harbour.

The main solar tide.

The main solar tide (R_2 of S) shows tolerably accordant results as regards amplitude at all three stations; the limits of variation are, 0·31 foot at both Diamond Harbour and Fort Gloster, and 0·36 at Kidderpore. It has generally been found that this tide agrees very closely, year by year, in India, the greatest difference in ten years at Kurrachee being 0·038, and for the two years at Bombay the difference is only 0·01. Still in seven years, at Liverpool, this tide varied as much as 0·26 foot, so the Hooghly values are about as correct as those deduced at Helbre island and Liverpool.

Epochs of main solar tide.

The epochs of the main solar tide vary by about 11° at Diamond Harbour, 24° at Fort Gloster, and 21° at Kidderpore; these, of course, are very great discrepancies; but again, as in the epoch of the main lunar tide, if the year 1875 be excluded, the variation at Fort Gloster would be reduced to 14°, and at Kidderpore to 18°. This also bears out what I have already stated, that the cause is due to the inattention of the person in charge to keep the clocks correctly to time.

Main solar tide also decreases as we ascend the river.

The amplitude half range of the solar semi-diurnal tide follows the same law as the main lunar, with regard to decreasing from Diamond Harbour upwards,—a phenomenon the reverse of what was noticed in the Gulf of Cutch. Taking the mean values, we get Diamond Harbour 2·12 feet, Fort Gloster 1·62 feet, and Kidderpore 1·38 feet.

The epochs of the main solar tides similar to the lunar.

The epochs taking the mean values are, Diamond Harbour 18°·5, Fort Gloster 72°·8, and Kidderpore 30°·7. These values would give the crest of this tide 1 hour and 49 minutes at Fort Gloster after Diamond Harbour, and 36 minutes after Fort Gloster it would reach Kidderpore; results almost precisely similar to what was found for the main lunar tide.

Combination of epochs of the true main tides.

Combining the results of the differences between the epochs of each of the two main tides (solar and lunar semi-diurnal), we should find that it ought to be, on the average, high water at Fort Gloster 1 hour and 42 minutes after Diamond Harbour, and at Kidderpore 2 hours and 14 minutes after Diamond Harbour.

The main diurnal and other diurnal tides on the Hooghly.

Diurnal inequality not much felt.

The main diurnal tide (R_1 of K) has very accordant values as regards amplitudes at all three stations, varying from 0·385 to 0·431 (*i.e.*, 0·046) at Kidderpore, from 0·398 to 0·482 (*i.e.*, 0·084) at Fort Gloster, and from 0·483 to 0·559 (*i. e.* 0·076) at Diamond Harbour.

At Kurrachee it varies in ten years from 1·167 to 1·442, *i.e.*, by 0·275 of a foot; but this tide is less than half in magnitude at the Hooghly stations of what was found at Kurrachee, and yet the main lunar tide at all three stations on the Hooghly is very much greater than the main tide at Kurrachee. The remaining diurnal tides compared to Kurrachee are as under, taking the average values deduced for each place :—

	R_1 of S.	R_1 of M.	R_1 of P.	R_1 of O.	R_1 of J.	R_1 of Q.
	Foot.	Foot.	Foot.	Foot.	Foot.	Foot.
Kurrachee	0·08	0·06	0·38	0 68	0·08	0·14
Diamond Harbour	0 08	0·04	0·17	0·25	0·04	0·02
Fort Gloster	0·08	0·04	0·16	0·22	0·04	0·02
Kidderpore	0·06	0·05	0·14	0·21	0·02	0·03

In all of which the values are relatively very small on the Hooghly, and when the magnitudes of the main lunar tides at the two places are considered, the proportions of the diurnal tides, as will be seen hereafter, are very much smaller than at Kurrachee.

Thus the diurnal inequality is not much felt in the Hooghly.

The quarter diurnal tides on the Hooghly.

The quarter diurnal tides (R_4 of M, R_4 of S, and R_4 of MS,) are all extremely large as compared with the values at other Indian ports (where observations have been taken and analysed), except those in the Gulf of Cutch; this is precisely according to theory, because the Hooghly may be considered an estuary.

Comparing these tides on the Hooghly with similar tides at Kurrachee and the Gulf of Cutch, the average values would be as under :—

	R_4 of S.	R_4 of M.	R_4 of MS.
Diamond Harbour	·14	·63	·64
Fort Gloster	·08	·62	·58
Kidderpore	·09	·55	·54
Okha (Gulf of Cutch.)	·01	·13	·06
Hanstal (Gulf of Cutch.)	·02	·68	·34
Kurrachee	·01	·02	·02

In the solar quarter diurnal, the values of the Hooghly tides are about ten times as great as they are at Kurrachee, or in the Gulf of Cutch; but it will be observed that at Hanstal (the head of the Gulf of Cutch) the value of this tide is also greater than at Okha (the mouth of the Gulf) or at Kurrachee. The values of the lunar quarter diurnal components of the Hooghly tides are all about the same as at Hanstal, at the head of the Gulf of Cutch, and again all about five times as great as at Okha; while at Kurrachee this tide is barely appreciable. In the compound luni-solar quarter diurnal, the Hooghly tides are in magnitude nearly double what was obtained at Hanstal; while at Kurrachee, Okha, and the west coast stations this tide is of exceedingly small magnitude.

These three-quarter diurnal tides are the co-efficients which make the whole resultant tide rise faster than it falls, as is generally observed in estuaries, and other localities separated from the ocean by considerable spaces of shallow water. This effect is of great practical importance in respect to navigation. Regarding the Helmholtz luni-solar tide (MS), the following remark is found in paragraph 73 of the Report by the Tidal Committee of British Association for 1870 .—"The harmonic analysis of this tide was given first by Airy. Helmholtz's admirable explanation of the grave and acute notes, heard accompanying two musical notes, sounding simultaneously, referred to in § 24 of the Committee's First Report, contains a perfectly general statement of an extremely simple character, which *mutatis mutandis* is applicable to the tides, in every case in which the range of rise and fall is sensible, in comparison with the mean depth through any considerable area of sea or channel" influencing them.

The quarter diurnal tides are those which make the water rise faster than it falls.

But the main features of the Hooghly tides are the magnitudes of the long period tides.

The main feature of the Hooghly tides.

The principal of these is the solar annual tide. The average value of the amplitudes obtained at Diamond Harbour is 1·08 feet, at Fort Gloster 1·82 feet, and at Kidderpore it is as much as 2·47 feet.

The solar annual tide.

The epochs of this tide are on the average 138° at Diamond Harbour, 151° at Fort Gloster, and 153° at Kidderpore: thus its maximum value would be felt about 9th August at Diamond Harbour, 22nd August at Fort Gloster, and 24th August at Kidderpore.

The amplitude of the solar annual tide has generally been found not to exceed 3 inches at Indian ports, and at Vizagapatam, where it was as great as 9 inches, it was considered an unprecedentedly high value, but more especially when taken in comparison with the value of the main lunar tide. The total rise and fall of the sea at Vizagapatam is small.

The values obtained for the solar annual tide, and the epochs being approximately the middle of August, appear to point clearly to the whole of this co-efficient being caused by the fresh water floods of the Hooghly.

Solar annual tide due to freshets.

The increasing value of this solar annual tide, from Diamond Harbour upwards, is also further proof of the cause, being from freshets in the river. For if the fresh water can for the moment be considered to be superimposed on the surface of the water influenced by tidal action, it is obvious as we descend the river there is more room for the "fresh-water layer" to spread out, and thus it would not be so thick. The width of the river at Fort Gloster is about the same as at Kidderpore, but at Diamond Harbour the river is nearly six times as broad, so at first sight it might appear that the "fresh-water layer" should have about the same "thickness" or height at Fort Gloster as at Kidderpore, and that at Diamond Harbour it should be only about one-sixth the height. Now at Kidderpore the value of the solar annual component is only about two and a half times as great as at Diamond Harbour, but it must be remembered that the Rup-Narain and Damoodah rivers fall into the Hooghly, between Fort Gloster and Diamond Harbour, and these rivers must discharge a large amount of fresh water during the south-west monsoon into the Hooghly, the influence of which would be felt at Diamond Harbour, but not at Fort Gloster or Kidderpore. Thus, although the river is six times as broad at Diamond Harbour as at Kidderpore, yet the value of the fresh-water solar annual

tide being about one-third what it is at Kidderpore, is not anomalous. Again, the magnitude of this "fresh-water component" being greater at Kidderpore than Fort Gloster, is what may be expected, for the current during the months July to September being almost entirely from Calcutta towards the sea, "the head of water," if I may so express it, would on this account diminish in descending the river.

The solar semi-annual tide.

The solar semi-annual tide, as a tide, is probably only felt at Diamond Harbour, where the amplitude is on the average about 0·2 foot, which is about the same as has been obtained at other Indian ports. But the amplitudes at Fort Gloster and Kidderpore being, respectively, about 8 inches and 1 foot, clearly indicate this tide as meteorological at those two stations. The epochs would appear to show that this tide reaches its maximum about the beginning of September, and again about the beginning of March, both at Kidderpore and Fort Gloster, the former date pointing to the cause being "freshes" in the river; and in March, too, there may be occasional floods in the river, caused by the heavy rains that frequently occur at that season.

The lunar monthly tide on the Hooghly.

The magnitude of the lunar monthly tide at all three stations is also greater than that obtained from any other observations hitherto analysed by me; at most Indian ports I have found the amplitude of this tide to be about 0·05 of a foot. At Diamond Harbour it is 0·15 foot, at Fort Gloster 0·19 foot, and at Kidderpore 0·26 foot. It is remarkable that the increasing value of this tide as we ascend the Hooghly is the same as was observed in the Gulf of Cutch, *viz.*, at Okha; the value was found to be 0·06 foot, and at Hanstal 0·11 foot.

The lunar fortnightly tide.

What has been said about the lunar monthly is almost precisely applicable to the lunar fortnightly. The values of the amplitudes of this tide are about 0·21 foot at Diamond Harbour, 0·28 foot at Fort Gloster, and 0·29 foot at Kidderpore. At the ports on the west coast of India, where tidal observations have been taken, the value of this tide was found to vary from 0·04 foot to 0·11 foot, except at Hanstal, where it was slightly greater, 0·14 foot. The value at Okha (mouth of Gulf of Cutch) was found to be 0·07, while at Hanstal (head of the Gulf) it was found to be (as above) about double, which compares well with Diamond Harbour and Kidderpore.

The luni-solar fortnightly tide.

The luni-solar fortnightly tide is also a remarkable feature in the Hooghly. The amplitudes are about 0·43 at Diamond Harbour, 0·68 at Fort Gloster, and 0·80 at Kidderpore; except in the Gulf of Cutch, this tide is extremely small at most Indian ports. At Okha, the mouth of the Gulf of Cutch, it was found to be 0·14, and at Hanstal 0·16, so that there also the increase as we ascend the estuary is felt.

The proportions between the various tidal co-efficients and the main lunar tide (taken as unity) on the Hooghly, may now be considered, in comparison with similar proportions at other places.

The proportion between the two main tides (solar and lunar) on the Hooghly.

The proportion of the main solar tide (R_2 of S) to the main lunar tide is, on the average, 0·450 at Diamond Harbour, 0·425 at Fort Gloster, and 0·415 at Kidderpore; and these proportions are very nearly the same as the equilibrium theoretical proportion (0·476), and more nearly in accord with it than has been observed at most places. Similar proportions were found at Aden, Bombay, and Vizagapatam.

The proportions between each of the lunar elliptic semi-diurnal tides and the main lunar tide.

The proportions of the larger lunar elliptic semi-diurnal tide (N) to the main tide are, 0·176 at Diamond Harbour, 0·172 at Fort Gloster, and 0·165 at Kidderpore—values nearly similar at all three stations, and only slightly less than the equilibrium theoretical value (0·192). At almost all the places in India where observations have been taken, this tide has borne too high a proportion to the main tide (about 0·25); but in the Gulf of Cutch it was found that at Okha the proportion was only slightly greater than the equilibrium value, while at Hanstal the proportional value was less (0·174), and the Hooghly proportions are almost exactly similar to what was found at Hanstal. The smaller lunar elliptic tide (L) is rather more than twice as great in proportion to the main lunar tide at the three stations on the Hooghly as the theoretical proportion (0·027). At both Diamond Harbour and Fort Gloster the proportion is about 0·060, while at Kidderpore it is 0·071; at most stations on the west coast of India this tide bears almost the same proportion to the main tide as theory would assign, but in the Gulf of Cutch, as in the Hooghly, the proportion is higher.

Proportions of the evectional tides to the main tide.

The larger evectional semi-diurnal tide (ν), is on the Hooghly about twice as great in proportion to the main lunar tide as theory would assign, *viz.*, 0·067 at Diamond Harbour, 0·076 at Fort Gloster, and 0·074 at Kidderpore; while the equilibrium theoretical value is 0·037. At Aden, Kurrachee, Bombay, Karwar, and Vizagapatam, the proportion of this tide was found to be almost double the theoretical proportion as in the Hooghly; while in the Gulf of Cutch, at Beypore, and at Paumben, the proportion almost agreed with the theoretical.

The smaller evectional semi-diurnal tide (λ) bears too high a proportion at the Hooghly stations, *viz.*, about six times as great as the theoretical; and it would almost appear as if this tide was influenced by shallow water; for at nearly all the stations in India, its proportion, although larger than the theoretical, is not much so, except at Paumben and at Hanstal, where the proportions are four to five times as great as the equilibrium-theoretical.

The proportion of the variational semi-diurnal tide (μ) to the main tide is very consistent year by year, at all three stations on the Hooghly, and on the average may be taken as 0·075 at Diamond Harbour, 0·069 at Fort Gloster, and 0·071 at Kidderpore, each of which is a little over three times as great as the theoretical proportion (0·022). With the exception of Paumben (where this tide is insignificant), the proportion usually found at Indian ports is accordant with the theoretical proportion. At Aden, Bombay, and Okha, the proportion is double the theoretical; while at Hanstal, the proportion is even greater than at the Hooghly stations, being nearly four times the theoretical value.

The variation tide in proportion to the main tide.

The proportion of the larger component (T) of the solar elliptic semi-diurnal tide agrees pretty well at Fort Gloster and Kidderpore, *viz.*, 0·026 and 0·037 respectively, with what theory would assign (0·028); but at Diamond Harbour the proportion is about double (0·062); at nearly every other place where this tide has been deduced the proportion agrees with theory.

The solar elliptic semi-diurnal tide compared to the main lunar tide.

The smaller solar elliptic semi-diurnal tide is, according to theory, very insignificant in comparison to the main tide (0·004), and at Indian ports this proportion has held good in almost every instance; but the proportions on the Hooghly are excessive; about sixteen times the theoretical, *viz.*, 0·068 at Diamond Harbour, 0·073 at Fort Gloster, and 0·057 at Kidderpore.

The proportion of the luni-solar declinational tide (R_2 of K) to the main lunar tide does not differ very greatly at the three Hooghly stations from the theoretical value, *viz.*, 0·168 at Diamond Harbour, 0·169 at Fort Gloster, and 0·175 at Kidderpore; while the equilibrium theoretical proportion is 0·127. At all the Indian ports where tidal observations have been reduced (except at Beypore and in the Gulf of Cutch, where the proportions are a good deal less than the theoretical), this tide agrees very closely in proportion to the main tide with the theoretical value.

The luni-solar declinational tide in proportion to the main tide.

The proportion of the luni-solar compound semi-diurnal tide at Kidderpore to the main tide is 0·017, a similar proportion to that existing at Aden, Hanstal, and Paumben, but about double what was found at other Indian ports; and again the proportions at Diamond Harbour (0·025) and Fort Gloster (0·031) are much higher than at Kidderpore.

The proportion of the luni-solar compound tide.

Now, with regard to the diurnal tides, the proportion of the solar diurnal (R_1 of S) to the main tide is 0·016 at Diamond Harbour, 0·022 at Fort Gloster, and 0·019 at Kidderpore, which (with the exception of Aden, Paumben, and Karwar) is accordant with what was found at other stations.

Comparison of the diurnal tides with the main lunar tide.

The proportions of the solar diurnal declinational tide (P) are as follows,—0·035, 0·040, 0·043 at Diamond Harbour, Fort Gloster, and Kidderpore respectively. This is a very much smaller proportion than is generally found at Indian ports (if we neglect Vizagapatam and Hanstal). This tide varies theoretically from one-tenth to one-fourth of the main lunar tide, and even at Vizagapatam and Hanstal (which were considered very small) the proportions are almost twice as great as in the Hooghly.

We now come to the main diurnal tide R_1 of K, and the proportion at all three stations is only about 12 per cent. of the main tide; *this for an Indian port is unprecedentedly small.* If we neglect Hanstal and Vizagapatam, this diurnal tide has an amplitude at Indian ports varying from 40 to 90 per cent. of the main tide, and even at Hanstal and Vizagapatam the proportion to the main lunar tide is about 0·250, or double what is found in the Hooghly.

The observations in the Bay of Bengal have not been as yet sufficiently advanced to determine if the diurnal tides are, or are not, so largely felt (in proportion to the total rise and fall) as on the west coast of India; and though the proportion at Vizagapatam would, in combination with the Hooghly values, lead one to suppose they were not so great in the Bay of Bengal, still this view must be taken with caution. I am inclined to think that, as regards the Bay of Bengal, the Gulf of Cutch tides bear some resemblance in their diurnal components, for it was observed that the main diurnal tide (R_1 of K) diminished in its proportion to the main tide, as we ascended the Gulf, from 42 per cent. at Okha to 25 per cent. at Hanstal. Now, as far as the reductions which are available show, if we consider Paumben as at the mouth of the Bay of Bengal, and the Hooghly as at the head, we have this main diurnal tide decreasing in proportion to the main lunar tide as we ascend the Bay, *viz.*, from 55 per cent. at Paumben to 26 per cent. at Vizagapatam, and again to 12 per cent. at the Hooghly.

The proportion of the lunar diurnal tide (R_1 of M) to the main tide is also smaller than at other Indian ports, and here we have another resemblance of the diurnal tides of the Hooghly to those at Hanstal; for the proportions to the main tide are 0·008 at Diamond Harbour, 0·012 at Fort Gloster, 0·016 at Kidderpore, and 0·018 at Hanstal, *i. e.*, about one-half what was found at other Indian ports.

The lunar declinational diurnal tide (O) has a proportion of about 6 per cent. of the main tide at the three Hooghly stations. Here, again, we find a diurnal component much less in value than at other Indian ports; if we neglect Vizagapatam and Hanstal (where the proportion is twice as great as on the Hooghly), the usual proportion of this tide to the main tide is from 20 to 30 per cent. At Karwar, the proportion found was 33 per cent., at Beypore 42 per cent., and at Aden (where, indeed, all diurnal tides were very great, the main diurnal tide actually being 90 per cent. of the main lunar), the proportion of this declinational diurnal tide (O) had a value almost equal to half of the main lunar tide.

The proportions of each of the lunar elliptic diurnal tides (J and Q) to the main tide are about one per cent. at each of the three stations on the Hooghly; at most other stations in India the proportion of the smaller of these tides (J) is from 2 to 4 per cent. of the main tide (at Aden it is about 8 per cent); but for the larger tide (Q) the proportion at Indian ports varies from 4 to 10 per cent. of the main tide.

Thus it will be observed that one of the main features of the Hooghly tides is the small value of the diurnal tides, and so the phenomenon of diurnal inequality is not marked in the Hooghly.

Proportion of the diurnal tides *inter se.*

We may now consider the proportions of some of the diurnal tides *inter se* on the Hooghly.

The proportion of the declinational tide P (the solar) to O (the lunar) varies from 0·61 to 0·94 at Kidderpore, from 0·53 to 0·92 at Fort Gloster, and from 0·55 to 0·76 at Diamond Harbour; the theoretical proportion would vary from 0·39 to 0·57, so that the tide component P is unduly large on the Hooghly.

The smaller elliptic lunar diurnal tide (J) is theoretically about 0·4 of the larger (Q); in the Hooghly (if we neglect the 1876 values at Fort Gloster), J varies from one-third to three times as great as Q, but then the amplitude of each of these tides is insignificant on the Hooghly.

The proportions between the lunar diurnal declinational tide (O) and the main diurnal tide (K) should vary from 0·657 to 0·764; on the Hooghly the proportion is less, about 0·50 at the three stations, which is very much the same as was found on the west coast of India.

Thus, although the diurnal tides on the Hooghly are exceedingly small in regard to the main lunar semi-diurnal tides, yet the proportions *inter se* do not present any great difference from what is found elsewhere in India.

Proportion of the overtides to the main tide.

We now come to the overtides, and first of all with reference to those of series S.

The solar quarter-diurnal tide (R_4 of S) is about 6 per cent. of the main tide at all three stations on the Hooghly, or about six times as great as at other Indian ports; both the other solar (R_6 of S and R_8 of S) overtides are insignificant at the three Hooghly stations, being less than 1 per cent. of the main lunar tide; and similar values obtain at other Indian ports.

The lunar overtides are much larger in proportion than the solar, notably the quarter-diurnal (R_4), which ranges from 13 per cent. of the main tide at Diamond Harbour to 16 per cent. at Fort Gloster, and 17 per cent. at Kidderpore. On the west coast of India the proportion is generally about 2 to 3 per cent. of the main tide; but this is a shallow water tide, and the effect of friction is clearly shown in the Hooghly, as in the Gulf of Cutch, from the augmentation of this overtide as the tidal wave proceeds up the river. At (Okha) the mouth of the Gulf of Cutch, the proportion of this overtide to the main tide was 3 per cent., and it increased to 10 per cent. at Hanstal, the head of the Gulf.

The lunar sexter-diurnal overtide (R_6 of M) is about 3 per cent. of the main tide at all three stations on the Hooghly; now this overtide is very small at other Indian stations; however, again, at Hanstal the proportion (0·04) is similar to the Hooghly proportion, and is actually slightly larger. With regard to the remaining overtides (R_4 of M) is about 1 per cent. of the main tide on the Hooghly, and this holds good also for the ter-diurnal component; but there is nothing remarkable about either of these tides, which are usually found to be insignificant, and even in shallow water localities are very small in magnitude.

The proportion of the amplitudes of the compound luni-solar quarter-diurnal tide MS. as compared with the sum of the amplitudes of the two main tides (R_2 of S and R_2 of M), varies from 0·09 at Diamond Harbour to 0·11 at Fort Gloster, and 0·12 at Kidderpore. The proportion usually obtained is rarely 3 per cent., and more frequently less than 1 per cent. at other Indian ports; but again at Hanstal it is 0·04, which approaches more to the Hooghly values.

But the main feature of the Hooghly tides, as I have previously stated, is undoubtedly the high proportions of the long period tides.

Beginning with the largest in amplitude, the solar annual, the proportion of this tide to the main lunar tide, varies from 23 per cent. at Diamond Harbour to 48 per cent. at Fort Gloster, up to the unprecedented proportion of 75 per cent. at Kidderpore.

Proportion of the solar annual tide to the main lunar tide.

It is rather remarkable to compare the various proportions of this tide. From Kurrachee to Okha and Bombay 4 to 6 per cent. of the main tide would appear to be the value; at Karwar it was found to be about 15 per cent., at Paumben 21 per cent., at Aden 25 per cent., at Beypore 34 per cent., and at Vizagapatam it reached the enormous proportion of one-half of the main tide.

Undoubtedly this tide is meteorological at all three places on the Hooghly. As I stated before, its maximum on the Hooghly occurring from the middle to the end of August would point to its being due to freshets in the river, while at the other Indian ports it is, I anticipate, due to wind.

It is curious that the epoch of this tide occurs successively later at each station on the west coast of India as we proceed north from Paumben, the only exception being Okha, thus—

At	Paumben	its maximum	occurs	about 28th	January.
„	Beypore	„	„	„ 2nd	February.
„	Karwar	„	„	„ 5th	„
„	Bombay	„	„	„ 27th	April.
„	Okha	„	„	„ 24th	March.
and „	Kurrachee	„	„	„ 13th	June.

At Vizagapatam the maximum occurs about the end of September, *i.e.*, during the south-west monsoon.

The increasing value of the solar annual tide from Diamond Harbour upwards, also points to this being a fresh water component, for the river widens at Diamond Harbour, and thus gives more space for the superincumbent fresh-water layer to spread out.

The proportion of the solar semi-annual tide.

The proportion of the solar semi-annual tide to the main tide is 4 per cent. at Diamond Harbour, 18 per cent. at Fort Gloster, and about 30 per cent. at Kidderpore. The epochs of this tide on the Hooghly are about the beginning of March and September. For the northern ports (Karwar, Bombay, Okha, and Kurrachee) on the west coast of India, the proportion of this tide in magnitude would be from 3 to 6 per cent. of the main tide, increasing as we go south to 16 per cent. at Beypore, and 24 per cent. at Paumben. The epochs in the case of this tide on the west coast are remarkable, getting later and later, as we ascend from Paumben to Bombay, and then getting earlier as we go north to Kurrachee and thence to Aden, thus—

Station.	Approximate time of maximum.
Paumben	9th May and 9th November.
Beypore	14th July „ 14th January.
Karwar	26th „ „ 26th „
Bombay	27th „ „ 27th „
Okha	4th June „ 4th December.
Kurrachee	23rd May „ 23rd November.
Aden	14th „ „ 14th „

But at Vizagapatam the times of maximum of this tide occur about the beginning of May and November, *i.e.*, earlier than at Paumben.

The proportion of the luni-solar fortnightly tide.

The next long period tide in importance on the Hooghly is the luni-solar fortnightly. This is one of the Helmholtz compound shallow water tides (tides which depend on the total rise and fall amounting to some sensible part of the whole depth of the water): it varies from 9 per cent. of the main lunar tide at Diamond Harbour to 18 per cent. at Fort Gloster, and 24 per cent. at Kidderpore. Now, except at Beypore and Vizagapatam, (where the proportions were 7 and 5 per cent. respectively, and the observations were made, just inside the mouth of the back-waters), the usual proportion of this tide to the main lunar is from 1 to 2 per cent.; so the Hooghly proportions must be considered remarkably high.

The lunar fortnightly tide in proportion to the main tide.

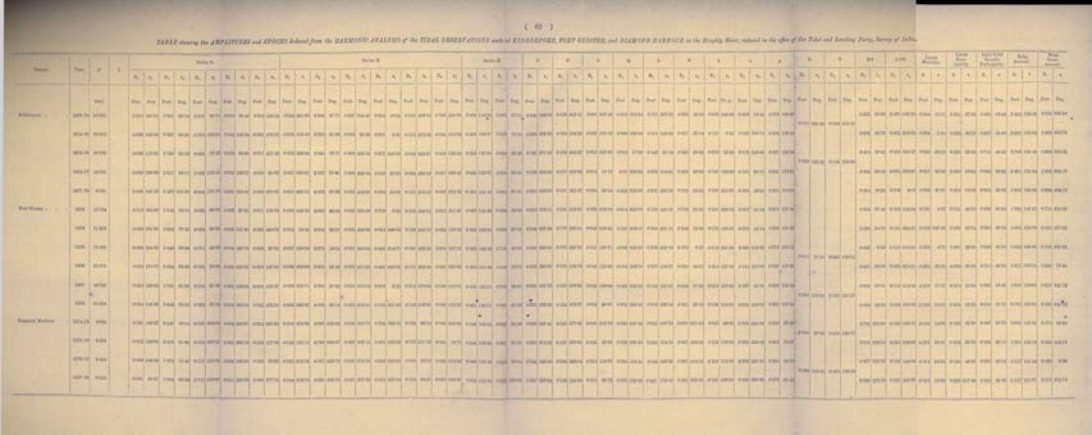
The next long period tide in importance is the lunar fortnightly, a tide which, I am informed by Sir William Thomson, he has been long looking for in vain, until confirmed by the values of the tidal constituents deduced by me from the observations at Indian ports. This tide has been found to vary from 2 to 12 per cent. of the main tide, and is usually about 2 per cent. of that tide; the values in the Hooghly are therefore higher than the average, the proportions being 5 per cent. at Diamond Harbour, 8 at Fort Gloster, and 9 per cent. at Kidderpore.

The lunar monthly tide in proportion to the main lunar tide.

The proportions of the lunar monthly to the main tide are 3 per cent. at Diamond Harbour, 5 per cent. at Fort Gloster, and 8 per cent. at Kidderpore.

Except at Beypore, where the proportion was found to be 8 per cent., and Paumben, where it was 10 per cent., the usual proportion of this tide is about 2 per cent. of the main lunar tide.

TABLE showing the AMPLITUDES and EPOCHS deduced from the HARMONIC ANALYSIS of the TIDAL OBSERVATIONS made at RIDDLESPORE, PORT DESPITE, and DIAMOND HARBOUR in the Hooghly River; entered in the office of the Tidal and Leveling Party, Survey of India.



GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Statement showing the nature of the work performed, and the progress made, from 1st October 1880 to 30th September 1881.

Maps.	Scale.	Remarks and Progress.
	In. Mls.	
India; 6 sheets, engraved, final ...	1 = 32	Additions and revisions from recent surveys to date, made on proofs of sheets 1 and 3. Hills drawn on a proof of sheet 4 for engraving. Hill shading on proofs of sheets 5 and 6 in progress.
India; 6 sheets, preliminary edition	1 = 32	Plate transfer proofs of the six sheets completed, and hills drawn for a preliminary issue by lithography.
India, No. 3; 4 sheets (with hills)	1 = 64	Additions and revisions from recent surveys to date, and all unsurveyed blanks filled in, to complete the plates in outline.
India, No. 3; 4 sheets (outline map)	1 = 64	New map of sheets 2 and 4 completed in outline for engraving. All names spelt agreeably to authorised lists; sheets 1 and 3 in progress.
India; 1 sheet. To illustrate the Trade Report.	1 = 96	Hills drawn, complete for press, on a proof of outline.
Rajputana Agency; 2 sheets ...	1 = 16	Additions made from recent surveys to date. Hill drawing completed for Engraving.
Central India Agency; 2 sheets ...	1 = 16	
Bengal; 2 sheets	1 = 16	Hill drawing completed.
Berar (Hyderabad Assigned Districts); 1 sheet.	1 = 8	Compiled and drawn in outline. Hill drawing in progress for engraving.
Assam; 1 sheet	1 = 16	Hills drawn complete.
Southern Afghanistan; 4 sheets ...	1 = 4	Compiled and drawn complete with hills, embodying all recent surveys to date, in progress.
Assigned Districts of Pishin and Sibi.	1 = 8	Compiled and drawn complete with hills for the Government of India. Extension on the south and east to embrace the British Frontier, in progress.
Punjab; 4 sheets	1 = 16	New compilation, embracing all recent surveys to date. Outline and names in progress.
Turkestan, Map of; in 4 sheets ...	1 = 32	Hills drawn complete in sheet 4, fifth edition.
Route map, Punjab, Kashmir, and the Western Himalayas.	1 = 32	Compilation and drawing in outline, of the western half, with revisions to date, in progress.
District Maps.		
Peshawar	1 = 4	Compilation and drawing from recent surveys, in progress.
Bannu	1 = 4	
Derá Ismáil Khán	1 = 4	
Derá Gházi Kháu	1 = 4	
Santal Parganas	1 = 4	Extracted from the sheets of the Atlas of India, and prepared and completed to date for publication.
Beerbhoom	1 = 4	
Ajmere	1 = 4	
Bulaghat	1 = 4	
Kamrup	1 = 4	
Basti	1 = 8	Drawn for the Gazetteer, North-Western Provinces.
Agra	1 = 8	
Index Maps.		
India, showing Imperial Surveys in progress to 1st October 1881.	1 = 128	Prepared for Departmental Report of 1880-81; small corrections and additions.
Atlas of India, showing state of engraving and publication to 1st October 1881.	1 = 256	
The Surveys of India (Topographical) showing the sheets published.	various	
Simla and Kalka Road Survey ...	1 = 2	Reduced and drawn from the 6″ sheets for reproduction.
Kohat District Topographical Survey	1 = 16	Drawn on vellum cloth for lithography.
South Sylhet and Tipperah Survey...	1 = 8	Drawn on vellum cloth for lithography
Districts and Circars of Berar and Hyderabad Native State.	1 = 32	Prepared on an extract from the 32-mile map of India for office use.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Sheets of the Atlas of India, 1 inch = 4 miles.

8, N.E.*	Part of Bahawulpur and District Dera Ghazi Khan.	Drawn in outline to extent of survey.
31, N.W. S.W. N.E. S.E. 32, N.E.	Parts of Montgomery, Ferozepore, Sirsa and Hissar Districts, and Patiala, Bahawalpur, and Bickaneer Native States.	Atlas reductions of Sirsa District and Bickaneer State examined and adjusted, and the sheets completed in outline from old surveys of the adjoining country, with revisions to date.
33, S.W.	Part of Jodhpore ...	Hills drawn complete.
36, N.W.	Part of Central India Agency ...	Drawn in outline to extent of survey.
37, S.E.*	Parts of Khandesh, &c. ...	Atlas reduction in outline to extent of survey examined, completed and adjusted.
38, N.E. S.E. S.W.* N.W.	Parts of Nasik and Ahmednagar Districts and Hyderabad.	Drawn in outline to extent of survey. Drawing in outline, in progress.
48, 48, N.E.* S.E.*	Districts Dehra Dun, Saharanpur, Amballa and Karnal, with Cis-Sutlej States.	Proof of old plate revised from recent survey of Jaunsar Bawar. Atlas reduction in outline of recent surveys examined and completed, and drawing in progress.
67, N.E. S.W. N.W.	Parts of Tarai, Kumaon, Moradabad, Budaon, and Bareilly Districts.	Drawn in outline complete. Drawn in outline to extent of materials received.
69, S. E. N.E.*	Parts of Cawnpore, Jaloun, Hamirpur, and Banda Districts.	Additions drawn in outline to extent of materials received. Drawn in outline to extent of new materials received.
71, S. E.	Parts of Districts Seoni and Mandla	Additions on east drawn complete with hills.
76, S. E.* 77, S. E.*	Parts of Districts North Arcot and Nellore, Madras Presidency.	Atlas reductions from Madras Revenue Survey examined and adjusted.
118, F. P.	Parts of Jalpaiguri, Cooch Behar, Goalpara and Bhutan.	Hills drawn on a dry print proof on the south-east part of sheet in Goalpara District.
125, S. E.*	Parts of District, Sylhet and Cachar	Drawing in outline; in progress.
126, N. E.	Part of Hill Tipperah and Sylhet	Additions drawn complete with hills from recent survey.
130, S. E.	Part of the Naga Hills, &c.	Hills drawn to extent of survey.

* The nine quarters marked * are new sheets.

Standard sheets of the Topographical Branch Survey of India, drawn for reproduction.

	Scale. In. mls.	
Hyderabad Survey, in 18 Sheets.		
Sheets 5, 8 $\frac{9 \text{ and } 10}{\text{in one}}$ 13 and 15 ...	1 = 1	Fair drawn complete with hills from the original field sheets.
Khasi, Garo, and Naga Hills Survey.		
Sheets $\frac{12 \text{ and } 13}{\text{in one}}$, $\frac{16 \text{ and } 17}{\text{in one}}$ ...	1 = 1	Unsurveyed blanks in the original sheets completed from recent surveys for a 2nd edition.
Sheets 13, 27, and 28 ...	1 = 2	Re-drawn complete with hills.
Rajputana Survey.		
Bickaneer city, plan of ...	2 sheets ...	Insertion of names from the field sheets on original drawing, with notes and references.

Miscellaneous Maps, Tracings, &c.

	In. mls.	
Cachar District showing locations of sundry tea gardens on the frontier.	1 = 4	Prepared from an original supplied by the Foreign Department.
Western Malwa Agency	1 = 16	Completed with notes, &c., on an extract from the 16-mile map of the Central India Agency, for the Political Agent.
Santhal Parganas District, Index to the.	1 = 8	Fifty copies corrected and out posts, roads, &c., added to agree with an original supplied by the Quarter-Master General's Department.
Rennel's map of Bengal ...	1 = 5	An extract made on vellum cloth for the Sub-Divisional Officer at Serampore.
Count Szechenyis travelled route from Sayang to Bamo.	1 = 12	Enlargement drawn complete with hills, for reproduction and office use.

GEOGRAPHICAL COMPILING AND DRAWING BRANCH, SURVEYOR-GENERAL'S OFFICE, CALCUTTA.

Miscellaneous Maps, Tracings, &c.,—continued.

	In. mls.	
The Bozdar's routes in Afghanistan, from the Sulimán through the 3406 valley &c.	1 = 4	A copy made on vellum cloth, with reduction of the same and an extract for departmental use.
Locations of the Waziri tribes on the British Frontier.	1 = 4	Additions from recent surveys compiled and drawn on transfer proofs of atlas sheets 5 and 15. For publication.
Index to the sheets of the Survey of Northern Afghanistan.	1 = 8	Trace made on vellum cloth.
Some sources of the River Irrawaddy, north of Bamo.	1 = 16	Reduced and drawn from the map accompanying the report of the recent exploration, with vignette additions, from various sources, for departmental report of 1879-80.

664 sheets of various engraved, lithographed, and photozincographed proofs, examined, corrected, or added to for publication in a complete form and for office use.

J. FRED. BANESS,
Surveyor and Chief Draftsman.

JOHN O. N. JAMES,
Assistant Surveyor-General,
In charge Drawing and Compiling Branch.

WORK DONE BY THE EXAMINING BRANCH, FROM 1ST OCTOBER 1880 TO 30TH SEPTEMBER 1881.

Subjects examined ...	Original standard sheets of Topographical Survey, and standard sheets compiled in Surveyor-General's Office, as also large scale plans and triangulation charts of the several topographical parties ...		49
	Original compilations of parts of atlas sheets and other maps compiled in Surveyor-General's Office		28
	Engraved proofs in outline, names, &c., in various stages, and general and provincial maps		121
	Photographed and lithographed proofs of various scales, including maps, plans, atlas sheets, &c. (examination and additions of new territorial boundaries)		303
Hill shading in brush and pen	Of atlas sheets in brush, and compilations in pen work		14
Work compiled ...	(Portions of atlas sheets and provincial maps, &c.) ...		9
Projection of graticule ...	(Projection of atlas sheets, and district provincial maps, &c.) ...		20
Miscellaneous work ...	Tracing of sketches and geographical data to various officials, computation of graticule for the plates of the Indian Atlas, and projection of the same on copper plates. Areas in the Central India Agency and Khandesh for the Statistical Department, reports, memoranda, &c.		

A. CHAMARETT,
Surveyor, Sec. II, Examining Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General,
In charge Drawing and Compiling Branch.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1880 TO THE 30TH SEPTEMBER 1881.

General Maps, &c.

Title of map.	Outline.	Writing.	Hills and Sand.	Remarks showing progress.
	Sq. In.	Letters cut.	Sq. In.	
Map of India, 32 miles = 1 inch—				
Sheet 1	.....	596	.....	Title and scale engraved.
„ 2	.....	.....	.....	Heavy additions.
„ 3	.....	1,871	.....	Ditto ditto.
„ 4	.....	1,122	.....	Ditto ditto.
Map of India in four sheets, scale 64 miles = 1 inch.	.....	13,768	104 H.	Heavy additions. Hills in progress.
Ditto ditto (skeleton map)	.....	5,435	.....	Writing in progress.
Map of India, scale 96 miles = 1 inch (skeleton map)	.....	699	.....	Heavy additions and corrections.
Map of Bengal in two sheets, scale 16 miles = 1 inch	.....	935	.....	Ditto ditto in progress.
Map of the Central Provinces in two sheets, scale 16 miles = 1 inch	500*	41,845	36 H.	Outline and writing done. Hills in progress.
Map of Rajputana in 2 sheets, scale 16 miles = 1 inch	.....	3,287	.....	Additions and corrections to outline and writing.
Chart of the Indian Ocean	200	28,822	236 Tint.	Plate finished. New map.
Map of Assam, scale 16 miles = 1 inch	.....	.....	.....	Slight additions.
Index Chart of the G. T. Survey of India	.....	.....	.....	Corrections and additions. Outlines and names completed.
Map of the Central India Agency in two sheets, scale 16 miles = 1 inch	24	1,288	.....	Corrections and additions to outline and writing done.
Map of Himalayan Routes	.....	4,780	.....	Plate put down, waiting orders.
Idiometer (machine)	.....	.....	.....	Completed.
Two fine tints, foolscap size, for Photographic Office, Poona	.....	.....	.....	Ruled and finished.
Chronograph	.....	.....	.....	Engraved as far as drawing.
Imprint plates 3	.....	.....	.....	Dates taken out and re-engraved for 1881.
Scale (4 miles = 1 inch)	.....	.....	.....	New scale for the sheets of the Indian Atlas, engraved and finished.

INDIAN ATLAS SHEETS (*New*) *completed and published.*

Atlas sheets—				
12 S. E.	17	341	32 H.	Completed up to margin.
33 N. W.	.....	.....	89 S. H.	Ditto ditto.
33 S. W.	.....	1,207	12 H., 68 S. H.	Ditto ditto.
35 S. E.	.....	.....	.....	Small portion of the plate left blank.
36 S. E.	45	1,372	133 H.	Completed up to margin.
66 N. E.	.....	.....	139 H.	Ditto ditto.
66 S. E.	.....	.....	148 H.	Ditto ditto.
86 S. E.	.....	.....	.....	Ditto as far as materials.
131 N. E.	.....	73	.....	Ditto up to limits of survey.

INDIAN ATLAS SHEETS (*New*) *in progress.*

8 S. E.	11	624	80 S. H.	Writing completed. Sand-hills well advanced—in progress.
18 S. E.	.....	.....	5 S. H.	New survey, outline and writing done. Sand hills in progress.
22 N. W.	.....	.....	.....	Slight additions. Plate put down.
31 N. W.	100	20,021	.....	Outline and writing finished. Hills in progress
31 S. E.	6	5,926	.....	Outline done and new border cut. Writing in progress.
31 S. W.	43	2,360	6 H.	Outline, writing and jungle as far as drawing, completed. Plate put down.
32 S. W.	.....	818	18 S. H.	Outline and writing completed. Sand-hills in progress.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1880 TO THE 30TH SEPTEMBER 1881.

INDIAN ATLAS SHEETS (*New*) *in progress*—concluded.

Title of map.	Outline.	Writing.	Hills and Sand	Remarks showing progress.
	Sq. In.	Letters cut.	Sq. In.	
Atlas sheets—				
35 N. W.	122	635	.....	Outline and writing completed as far as drawing. Hills just commenced—in progress.
35 S. W.	.....	224	33 H.	Writing as far as drawing, completed. Hills just commenced.
36 N. W.	4	1,416	.....	Outline and writing as far as drawing, completed; plate put down.
36 N. E.	43	6,723	20 H.	Outline and writing, finished as far as drawing. Hills, just commenced.
38 N. E.	44	2,814	.....	Outline done. Writing in progress.
38 S. E.	76	1,600	.....	Outline done. Writing nearly finished as far as drawing.
48 N. E.	39	2,229	.....	Outline done. Writing in progress.
48 S. E.	150	.....	.....	Outline nearly done. "New plate."
53 N. W.	.....	14,040	.....	Corrections to writing, done.
66 N. W.	.....	.....	100 H.	Hills well advanced.
66 S. W.	23	1,145	26 H.	Outline and writing done. Hills just commenced.
67 N. W.	138	.....	.....	New border cut. Outline well advanced.
67 N. E.	128	2,000	.....	New border cut. Outline done. Writing in progress.
67 S. W.	28	.....	.....	New border cut. Outline in progress.
67 S. E.	228	14,174	.....	New border cut. Outline done. Writing well advanced.
69 N. E.	.....	.....	.....	New border cut. Outline just commenced.
77 N. E.	18	743	.....	Outline and writing completed.
129 S. E.	.....	7,041	63 H.	Writing completed. Hills well advanced.
130 S. E.	.....	.....	78 H.	Hills almost finished.
Additions and corrections to Indian Atlas Sheets.				
18 N. W.	.....	72	.....	Slight additions.
18 N. E.	3	72	24 S. H.	District names and small portions of fresh survey finished.
32 N. E.	92	2,545	30 S. H.	Heavy additions. Outline, writing, and sand-hills completed.
37 N. E.	.....	264	.....	Slight additions.
45 N. W.	.....	.....	.....	Ditto ditto.
45 S. W.	.....	28	.....	Ditto ditto.
51 N. E.	.....	.....	.....	Ditto ditto.
53 S. W.	4	177	.....	Alterations and additions to outline and writing completed.
63A S. W.	.....	674	.....	Slight additions.
64 N. W.	.....	.....	.....	Ditto ditto.
69 N. W.	.....	195	2 H.	Ditto ditto.
69 N. E.	.....	154	.....	Heavy additions to outline and writing.
69 S. W.	23	1,145	8 H.	Additional outline, writing and hills, completed.
71 S. W.	.....	.....	8 H.	Corrections to outline, writing, and hills, done.
71 S. E.	95	7,543	.....	Outline and writing, done.
86 S. W.	.....	.....	.....	Slight additions.
87. N. W.	.....	.....	.....	Ditto ditto.
91. N. E	.....	.....	.....	Portion of hills repaired, and corrections to writing.
124 S. E.	.....	.....	.....	Slight additions.
125 N. W.	.....	.....	.....	Ditto ditto.
125 N. E.	.....	.....	.....	Ditto ditto.
126 N. E.	5	165	.....	Small portion of old work taken out for insertion of new work. Outline and writing done.
129 N. W.	.....	.....	.....	Slight additions.
129 S. W.	.....	.....	.....	Ditto ditto.
130 N. W.	.....	.....	.....	Ditto ditto.
131 N. W.	.....	.....	.....	Ditto ditto.

PROGRESS REPORT OF THE ENGRAVING BRANCH FROM THE 1ST OCTOBER 1880 TO THE 30TH SEPTEMBER 1881.

Repairs and additions to old plates of the Indian Atlas.

Title of map.	Outline.	Writing.	Hills and Sand.	Remarks showing progress.
	Sq. In.	Letters cut.	Sq. In.	
16	.....	370	.....	District names and additions done.
17	.....	176	.....	Ditto ditto ditto.
25	.....	.....	4 H.	Small portion of hills repaired.
29	.....	24	.....	District names done.
30	.....	80	.....	Ditto ditto ditto.
31	.....	56	.....	Ditto ditto ditto.
38	.....	5,277	183 H.	Repairing, writing, and hills, finished.
46	.....	.....	33 H.	Repairing, writing, and hills, in progress.
49	.....	.....	.....	Slight additions.
50	2	674	.....	Ditto ditto and district names done.
54	.....	44	.....	Slight additions and district names done.
65	.....	.....	70 H.	Heavy additions. Hills well advanced. Plate put down for more urgent work.
79	.....	.....	53 H.	Repairing hills. Plate put down.
106	.....	.....	117 H.	Ditto ditto ditto.
118	62	7,035	.....	New survey, outline, and writing, done.
119	.....	36	.....	Slight additions.
120	.....	2,549	.....	Repairing, writing, and additions, done.

New Plates projected and Borders cut.

69 N. E. and S. E.	.....	.....	.....	Projected, and new borders engraved.
57 Four Quarters	.....	.....	.....	Ditto ditto.
153 Ditto ditto	.....	.....	.....	Ditto ditto.
8 N. E.	.....	.....	.....	Ditto ditto.
40 Four Quarters	.....	.....	.....	Projected, and new borders in hand.
144 Ditto ditto	.....	.....	.....	Ditto ditto ditto.
145 Ditto ditto	.....	.....	.....	Ditto ditto ditto.

ABSTRACT OF WORK COMPLETED AND IN PROGRESS.

Engraving.

	Plates.
Atlas sheets completed	9
Ditto in progress in various stages	52
General maps and plans, &c.	21
Repairs, corrections, and additions	17
Projections and engraved borders cut, &c.	23

Steel facing.

Double elephant plates steel faced	27
Ditto ditto re-steeled	3
Quarter plates steel faced	60
Ditto ditto re-steeled	6
Miscellaneous plates, steel faced	6
Ditto, re-steeled	2
Total plates	104

Copper-plate printing.

Impressions taken	7,262
Proofs pulled	900
Transfers pulled	291
Total	8,453

Square inches of hill etching	1.958
Ditto outlines	2,273
Number of letters engraved	228,121

C. W. COARD,
Superintendent, Engraving Branch.

JOHN O. N. JAMES,
Assistant Surveyor-General,
In charge Engraving Branch.

Table A.

Tabulated Statement of the principal records prepared in the several Executive Offices of the Revenue Branch for the year ending 30th September 1881.

Province and District.	Survey Party.	Cadastral 16-inch sheets.	Sheets 4 inch = 1 mile.	Quarter sheets 2 inch = 1 mile 15′ × 7½′	Reduction for Atlas of India.	Triangulation charts.	Index Maps.	Original Field sheets.	For Settlement Department.	
									Sheets or Traces.	Village areas or Khasras.
N. W. Provinces.				**Cadastral Surveys.**						
Ghazipur	No. 4	1,007	...	6	Under preparation.	...	1	Same as cadastral sheets.	...	1,389
Ballia	Ditto	133	...			...	...		89	86
Mirzapur	No. 5	1,059	...	...		...	1		...	924
Tarai	Ditto	38	...	...		...	...		...	20
Banda	Ditto	574	47	...		...	...		...	...
Jaunpur	No. 6	1,008	11	23		...	1		...	1,041
British Burma.										
Hanthawaddy	No. 2	1,113	...	18		...	1		480	480
Tharrawaddy	No. 7	497	...	7		...	2		497	151
Bassein	No. 8	747	60	4		...	1		187	187
Punjab.				**Village and Topographical Surveys.**						
Dera Ismail Khan	No. 1	...	67	...	...	...	1	...	54	...
Rawalpindi	Ditto	...	13 (7½′ × 3¾′)	...	...	...	...	...	...	...
Do. and Hazara Hutted Camps	Ditto	...	5 on 12″	...	...	1 on 2″ scale	...	5 on 12″ scale	...	...
N. W. Provinces.										
Meerut	No. 3	...	...	30 for reproduction. 34 for reduction.	Portion of sheet 49.	...	...	80	...	...
Bulandshahr	Ditto	...	...	...	...	...	...	...	...	...
Jumna River Survey	Ditto	...	18	...	...	...	...	...	...	...
Bombay.										
Thana and Kolaba	No. 10	...	...	24	Portion of sheet 39.	1 on ½″ scale	2 on ½″	32 on 2″ scale	24 traverse charts.	1 volume traverses.
Sholapur, Satara, Kaladgi and Nizam's Dominions	No. 11	...	...	19	Portion of sheets 39, 40, 56 and 57.	2	2	31 on 2″ scale	19 traverse charts.	...

Deputy Surveyor General's Office,
Calcutta, 1st October 1881.

F. CODDINGTON, *Major*,
Deputy Superintendent at Head Quarters.

Table B.

Statement of Work performed in the Drawing and Compiling Branch of the Deputy Surveyor-General's Office during the year ending 30th September 1881.

Title of Map.	Scale.	Remarks.
Punjab.	Inch. Mile.	
Districts Bannu and Dera Ismail Khan, in 41 standard sheets, size 30′ × 15′.	1 = 1	The original 4-inch maps, drawn in the Executive's Office, have all been reduced to half scale by photozincography. The 2″ blue prints of sheets 2, 3, 10, 14, 15, 33, and 36, have been inked up and examined, and (except sheet 36) have been sent to press. Sheets 6, 7, 11, 13, and 16 commenced last year, have also been examined and sent to press: also sheets 5, 9, 17, 21, and 25, which had been previously examined, making in all 16 sheets. Sheets 20, 28, 29, 32, previously sent to press, have been published during the year.
		Number of sheets published up to date, 25.
Districts Rawalpindi and Hazara :		
Hutted Camps—		
At Changla Gali . . .	12 = 1	The original maps drawn in the Executive's Office were examined before being sent to press for reproduction to scale. The proof sheets were subsequently examined, and press order given.
„ Khyra Gali		
„ Khobba		
„ Bara Gali and Kalabagh .		
„ Ghora Dhaka and Kunja Gali		
		The publication has been completed.
North-Western Provinces.		
District Moradabad, in 13 standard sheets, size 30′ × 15′.	1 = 1	The 2″ blue prints of sheets 31, 32, 33, 47, 48, 49, and 50, have been typed and re-drawn in black for reduction, making 11 sheets drawn up to date. The examination of the whole is well advanced. Sheets 65 and 66 are being mapped with Rampur State into which they run.
		No sheets have yet been published.
District Budaun, in 11 sheets, standard size 30′ × 15′.	1 = 1	Geographical lines have been inserted on 44 of the 4-inch maps, comprising standard sheets 68, 69, 70, 84, and 85, and sent to press for photo reduction to half scale. The 2-inch blue prints of sheets 33, 34, 50, 52, 69, 70, and 85, were typed and re-drawn in black during the year. Examination is in progress. Drawing of the remaining sheets 51, 67, 68, and 84, is in hand.
		No sheets have yet been published.
District Banda, in 15 sheets, standard size 30′ × 15′.	1 = 1	Geographical lines have been inserted on 83 of the 4-inch maps, comprising standard sheets 109, 110, 111, 124, 125, 126, 140, and 141, for reduction; and 2-inch blue prints have been received. The typing and drawing are not yet commenced. The 4-inch sheets comprising the remaining sheets have not yet been submitted by Executive Officer.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
Punjab—*contd.*	Inch. Mile.	
District Saharanpur, 10 sheets, for reduction to half scale . . .	1 = 1	The maps have been drawn in the Executive's Office: one set (fine) showing village boundaries for reproduction to scale in ¼ sections measuring 15′ longitude by 7½′ latitude; the other set (coarse) without village boundaries, for reduction to 1-inch scale. These sheets have been examined, corrected, and rendered suitable for press. Published up to date 1 sheet, No. 14, on 1-inch and 2-inch scales.
10 sheets for reproduction to scale .	2 = 1	
Districts Muttra and Agra, portions of	4 = 1	20 sheets examined previous to publication by photozincography, for Irrigation Department. Number of sheets published to date, 20.
Rampur State, in 4 sheets, standard size 30′ × 15′.	1 = 1	Geographical lines have been projected, and sheets traced from the manuscript 2-inch maps. Typing and drawing are in progress. The State is comprised in sheets 64, 65, 66, 67; the western portions falling within sheets 47, 48, 49, 50, will be mapped with District Moradabad.
Oudh (new edition), in 65 sheets, standard size 30′ × 15′.	1 = 1	The original maps with graticule lines inserted, comprising standard sheets 138, 139, 140, 152, 153, and 154, have been sent to press for lithography. Since last report, sheets 100, 129, and 130, have been published. Number of sheets printed to date, 4.
Bengal.		
District Midnapore, in 18 sheets, standard size, 30′ × 15′.	1 = 1	The remaining 2-inch sheets 8, 11, 14, 17, have been drawn, examined, and sent to press. The only sheet unpublished is No. 17, the proof of which is detained for insertion of level bench marks and heights by Irrigation Department. Number of sheets printed to date, 17.
District Noakholly, in 12 sheets, size 30′ × 15′.	1 = 1	Proofs received from Collector have been examined and sent to lithographic press. Final press order has not yet been given.
District Jalpaiguri, in 13 sheets, size 30′ × 15′.	1 = 1	Lithographic proofs sent to Deputy Commissioner for examination, but not yet returned. Several alterations will have to be introduced on the proofs in accordance with Captain Harman's survey of the Darjeeling frontier in 1880-81.
Bombay.		
Deccan Topographical Survey, 2 inches = 1 mile, including the Konkan, in 96 sheets, standard size 30′ × 15′.	1⅓ = 1	Since last report 2-inch standard sheets 14, 18, 22, 25, 29, 29A, 31, 33, 34, 46, 50, 50A, 54, 55, 56, have been examined, corrected, completed for publication, and sent to press. All (except sheets 14 and 25) have been published; these, together with sheets 26, 27, 28, 32, which were sent to press last year, make 17 sheets, published during 1881. Sheet No. 11 has been completed by the addition of a small portion of the Konkan (by hand) in the south-west corner. Number of sheets printed to date, 67.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
Bombay—*contd.*	Inch. Mile.	
Atlas Reduction, for Indian Atlas sheets 39, 40, and 56, Deccan.	$\frac{1}{4} = 1$	Prepared in the Executive's Office, re-examined with 1-inch sheets in Head Office, corrected and sent to Surveyor-General's Office for engraving.
Atlas Reduction, for Indian Atlas sheet 48, Districts Saharanpur and Mozafarnagar.	$\frac{1}{4} = 1$	Do. do. do.
District Midnapore . . .	$\frac{1}{4} = 1$	Under compilation in Head Office from 1-inch standard sheets. About one-eighth completed.
Index Maps.		
Districts Dera Ismail Khan and Bannu, Rawulpindi, Hanthawaddy, North-West Provinces, Ghazipur and Ballia, Jaunpur, Bassein, Deccan and Konkan.	On various scales.	Brought up to date and republished for insertion with the Annual Report for 1880-81.
District Tharrawaddy . . .	$\frac{1}{8} = 1$	Compiled for Annual Report, 1880-81.
Miscellaneous traces, &c.		
Skeleton plan of Mouza Jajarsing, Khorda Estate (8 sections).	$32 = 1$	Traced for Settlement Office.
Plan of sub-divisions 1 to 6, Grand Division I, Punchannogram Estate.	1=300 ft. $300 = 1$,,	Traced for Collector.
Twelve Atlas sheets, Ganges Deara Survey, 1867-68, with course of Ganges River, as surveyed in 1848-55, added in red.	$4 = 1$	Traced for Collector of Moorshedabad.
From sheets 24, 25, 30, and 31, Ganges Deara Survey.	$4 = 1$	Traced for Collector of Furreedpore.
One Atlas sheet and 6 village plans .	$4 = 1$	Traced for Sub-Deputy Collector of Barh, Patna.
Sheets 26 and 34, District Peshawar .	$4 = 1$	Traced for Deputy Assistant Quarter-Master General, Rawalpindi Division.
Villages in Pargana Kootubdia, District Chittagong.	$4 = 1$	Traced for Superintending Engineer.
Do. of General Map Do. .	$1 = 1$	
Boundary between Goalpara and Garo Hills.	$4 = 1$	Traced for Deputy Commissioner, Garo Hills.
Twenty-four villages of District Tirhoot.	$4 = 1$	Traced for local officials.
Sheets of Khorda boundary on Chilka Lake; also hills in and near the lake.	$4 = 1$	Traced for Settlement Officer.
Hills in sheets 21 and 33, Khorda .	$4 = 1$	Do. do.
Plan of 1 village, District Bhagulpore	$4 = 1$	Traced for Collector.
Boundary between Jungal Mahals Jamirapal and Ulmara, District Midnapore.	$4 = 1$	Traced for Civil Superintendent of Survey, District Midnapore.
Boundary between Districts Kamrup and Goalpara.	$4 = 1$	Traced for Board of Revenue, Lower Provinces.
Atlas sheet No. 122, District Luckimpore.	$4 = 1$	Traced for Deputy Commissioner.
12 plans of grants of District Cachar	$4 = 1$	Copied for Deputy Commissioner.
2 plans of villages of District Purneah	$4 = 1$	,, for Collector.
4 plans of grants of District Sibsagor	$4 = 1$	,, for Deputy Commissioner.
3 plans of villages of District Jalpaiguri.	$4 = 1$	,, for Deputy Commissioner.
3 plans of villages of District Shahabad.	$4 = 1$	,, for Deputy Collector.

Table B.—*continued.*

Title of Map.	Scale.	Remarks.
	In. Mile.	
Boundary of Pargana Kashipur, district Tarai.	4=1	Traced for Deputy Superintendent.
Boundary between Districts Bareilly and Tarai.	4=1	
Boundary betwen Rampur Jagir and District Tarai.	2=1	
Boundary between village and Thal, portions of District Mozaffargarh.	4=1	Do. do.
8 villages of District Sialkot adjoining Jummoo State.	4=1	
Lieutenant Robinson's map of boundary between British and Jummoo Territories, 1850-51.	1=1	
Plans of 47 villages, District Sylhet .	4=1	Traced for Deputy Superintendent.
Detached portions of District Jaunpur falling in Oudh.	4=1	
One Atlas sheet, Ganges River survey	2=1	Traced for Collector of Monghyr.
Sheets 2, 3, and 4 of map of Sarda River and boundary between Nepal and Rohilkhand, 1863.	2=1	Traced for Resident at Nepal.
Traverse blocks, sheets 26, 30 35A, 35, 43, Deccan Topographical Survey (with Index to Traverses on $\frac{1}{2}$″ scale) (18 sections).	2=1	Traced for Superintendent, Revenue Survey and Assessment, Poona and Nassik.
Maps of Parganas Seraen, Chowbees-Koond, Khorda Estate.	2=1	Traced for Settlement Officer.
Boundary between North-West Provinces and Nepal.	2=1	Traced for Resident at Nepal.
Kosi River boundary between Rampur Jagir and Parganas Kashipur and Moradabad, with adjoining villages on both sides.	2=1	Traced for Commissioner, Rohilkhand Division.
Index map showing lines of levels in Pargana Hassanpur, District Moradabad, 1870-76.	$\frac{1}{2}$=1	Traced for Director, Agriculture and Commerce Department, North-West Provinces and Oudh.
Triangulation Chart, District Hazara	$\frac{1}{4}$=1	Traced for Deputy Superintendent.
Map showing extent of damage done to North-West Provinces records during 1857.	$\frac{1}{16}$=1	Do. do.
Reduction from 4″ sheets of Bijnor, showing boundary and topography along Ganges River on District Saharanpur.	2=1	For office record.
Index map showing Hooghly River and adjacent country, Calcutta to Saugor Island.	$\frac{1}{4}$=1	For Surveyor-General.
Map Colouring.	*No. of maps.*	
2 maps on $\frac{1}{4}$″, 89 on 1″, 4 on 2″ and 2 on 12″ scales.	97	For Surveyor-General's Office.
2 maps on $\frac{1}{4}$″, 89 on 1″, 4 on 2″ and 2 on 12″ scale.	97	„ Deputy Surveyor-General's Office.
500 on 1″, 40 on 2″, and 20 on 12″ and larger scales.	560	„ The Secretary of State for India.
Specimen maps on various scales .	80	„ Venice Geographical Exhibition.
2 maps on $\frac{1}{4}$″, 542 on 1″, 44 on 2″, 20 on 4″, and 29 on 10″ and larger scales.	637	„ Government officials.
Total . .	1,471	

Table B.—*concluded.*

Description of Work.	Remarks.
Examination of proof-sheets.	
Photozincograph maps . . . . 181 Lithograph maps 47	For publication.
Traverse data, &c., supplied.	
Of Districts Bareilly, Moradabad and Rampur State along District Tarai.	For Deputy Superintendent.
Of detached villages of District Jaunpur in Oudh.	Do. do.
Specimens of traverses and field area statements, North-West Provinces Cadastral Surveys.	For Geographical Congress at Venice.
Cachar Grants (34 pages)	„ Deputy Commissioner.
Khorda traverses on Chilka Lake	„ Settlement Officer.
Chittagong village traverses and area statements.	„ Office record.
Agra alphabetical indices	Do. do.
Patna district alphabetical indices . . .	„ Collector.
Values of triangulated stations around Murree	„ Deputy Superintendent.
Area of villages in main circuits 7, 8, 8A, 9 of Khorda.	„ Settlement Officer.
Computations examined.	
District Banda	Seasons 1874-76
District Pooree (Khorda Estate) . . .	„ 1875-80
District Saharanpur	„ 1877-79
	Final examination.
Miscellaneous Work.	
Insertion of bench marks and heights on 2″ sheets of District Budaun.	For Irrigation Department, North West Provinces.
General Sheet Index for India, showing state of publications.	„ Office record.
Statement showing area, season and character of survey of all the districts in Bengal with coloured ind x map.	„ Secretary, Revenue and Agricultural Department.
Statement of North-West Provinces and Oudh of surveys made since 1830.	„ Director, Agricultural Department
Calculation of areas of Deccan Collectorates according to Talukas; of Saharanpur district according to parganas, of Kohistan of Shikarpur Collectorate; of Districts Kumaun and Garhwal, and Jaunsar Bawar of District Dehra Dun, from 1″ and 2″ maps.	„ Government officials.
Insertion of Bench Marks, heights in 4″ sheets of District Gya.	„ Office record.
Correction of maps and records according to changes notified in Gazettes, &c.	„ Local Governments and office record.
Calculation of co-ordinates for projection of 1″ standards of Districts Banda, Dera Ismail Khan and Rampur State.	„ Office use.
Insertion of Kohistan limits on 15 sheets 1″= 1 mile, of Sind Collectorates.	„ Civil Superintendent, Sind Revenue Survey.
Insertion of main circuit and sheet limits of revenue survey publications, on 16 miles=1″ map of Bengal.	„ Bengal Government.

Deputy Surveyor General's Office,
Calcutta, 1st October 1881.

F. CODDINGTON, *Major.*
Deputy Superintendent at Head Quarters

Table C.

Statement of Publication of Cadastral Maps for year ending 30th September 1881.

NUMBER OF SHEETS.

Districts.	Maps prepared			Published				Remarks.
					During 1881.			
	Up to 30th September 1880.	Added during past 12 months.	Total up to 30th September 1881.	Up to 30th September 1880.	By Surveyor-General's Office.	Total up to 30th September 1881.	Remaining to be published.	
N.-W. Provinces.								
Agra	(a) 2,924	.....	2,924	(a) 2,915	9	2,924	.....	(a) Figures of previous return have been changed to agree with final results.
Azamgarh	930	.....	930	930	.....	930	.....	
Banda	3,329	3	(b) 3,332	2,380	564	2,953	(b) 379	
Bijnor	31	.....	31	31	.....	31	.....	
Ghazipore and Ballia	1,686	1,022	(b) 2,708	580	1,454	2,034	(b) 674	(b) These figures are liable to alteration until publication has been completed.
Hamirpur	2,926	...	2,926	2,926	.....	2,926	.....	
Jaunpur	2,453	982	(b) 3,435	1,774	1,115	2,889	(b) 546	
Moradabad and Tarai	4,023	.....	4,023	4,023	.....	4,023	.....	
Muttra	1,658	.....	1,658	1,658	.....	1,658	.....	
Mirzapur	882	1,053	(b) 1,935	181	948	1,129	(b) 806	
Tarai	.....	40	(b) 40	.....	.....	.....	(b) 40	
Total	20,842	3,100	23,942	17,407	4,090	21,497	2,445	
British Burma.								
Bassein	510	672	(b) 1,182	.....	119	119	(b) 1,063	
Hanthawaddy	1,043	1,169	(b) 2,212	.....	843	843	(b) 1,369	
Pharrawaddy	.....	497	(b) 497	.....	.....	.....	(b) 497	
Total	1,553	2,338	3,891	.....	962	962	2,929	
Bengal.								
Patna and Gya	3,054		3,054	3,054	.....	3,054	.....	
Shahabad	4,924	.....	4,924	4,924	.....	4,924	.....	
Pooree (Khorda Estate)	(a) 3,335	.....	(b) 3,335	1,010	.....	1,010	(c) 2,325	(c) Publication discontinued for the present at request of Board of Revenue, Lower Provinces.
Total	11,313	.....	11,313	8,988	.....	8,988	2,325	
Grand Total, N.-W. Provinces, Burma, and Bengal	33,708	5,478	39,146	26,395	5,052	31,447	7,699	

Detail of examination in connection with the year's publication.

Province.	Number of Sheets				Remarks
	Examined and numbered suitable for Photozincography.	Traced and examined for Zincography.	Proof copies examined previous to press order.	Corrected and finally examined.	
North-West Provinces	2,386	1,121	4,035	4,090	Scale, 16 inches to a mile.
British Burma	1,469	199	1,189	962	Ditto.
Bengal	.....	.....	...	.....	Scale, 32 inches to a mile.
Total	3,855	1,320	5,227	5,052	

DEPUTY SURVEYOR-GENERAL'S OFFICE;
Calcutta, 1st October 1881.

I. CODDINGTON, *Major*,
Deputy Superintendent at Head-Quarters.

W

Extracts of Report of MAJOR R. V. RIDDELL, R.E., *Assistant Surveyor-General, in charge Lithographic Branch, Surveyor-General's Office—Season 1880-81.*

The total number of sheets or items turned out amounted to 997, or 500 in excess of those of the previous year. This large excess is due to the circumstance that in it 466 cadastral maps are included, which were printed but not drawn in this office, the traces having been drawn in the office of the Deputy Surveyor-General.

As stated in the report of the work of this office for last year, the stock of several of the sheets of the Oudh map, on the scale of 1 inch=1 mile, had become nearly exhausted. These sheets comprised 30′ of long. by 20′ of lat; but as their size has been found inconvenient, the sheets of the new edition will comprise 30′ long. by 15′ lat. Whenever the stock of any sheet of the old series requires to be replenished, as many of the sheets of the new series as contain any portion of the area shown in the sheet of the old series will be re-drawn simultaneously, in order that there shall always be some map of every portion of the country available for issue either from the old series or from the new.

Transfers of the sheets of the Atlas of India, Nos. 41, 48, and 131, were obtained from the engraved plates, and printed during the year; large and important additions of outline and names carried out, either direct on the stone or on transfer paper. The engraved plate of Atlas sheet No. 48 had become so worn that only a very faint impression of the hill etching could be obtained. There is always a great demand for copies of this sheet, which is full of detail: a fresh plate could not have been prepared in time to meet the demand; consequently, in order to provide for *ad interim* requirements, it was determined to make a transfer to stone and re-draw the hills, making corrections, where necessary, from information derived from surveys of recent date. As a specimen of hill drawing on stone by a native draftsman, this is considered an excellent piece of work.

The accompanying Statements show the detail of the departmental work completed during the year, amounting in value to Rs. 21,586; the amount and value of work done for other departments, amounting to Rs. 17,979; the amount and value of the work done in the type department, exclusive of value of transfers already included in the cost of the several lithographic maps; and the abstracts of the whole work completed during the year, as well as the outlay in salaries and contingent charges actually spent.

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1880 AND 30TH SEPTEMBER 1881.

Work done for the Survey Department.

DESCRIPTION OF MAPS.	Description of work done.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies printed.	Number of impressions.	Value.	REMARKS.
New Maps, &c., drawn during the year.										
GENERAL MAP.									Rs. A. P.	
Map of Southern Afghanistan, in 4 sheets (Photo-lithograph).	Additions, corrections, &c., made.	1 inch= 4 miles	Antiquarian...	4	...	600	600	1,200	1,258 2 0	
DISTRICT MAP.										
Map of District Hoshiarpur, in 4 Sections.	Drawn on transfer paper.	1 inch= 2 miles	Atlas ...	4	...	...	...	...	696 11 0	Transfer drawning supplied to Photographic Branch.
INDEX MAPS.										
Index to the sheets of District Kohat	Drawn on transfer paper.	...	Half-sheet foolscap.	1	...	62	62	62	28 11 2	
Index to the Survey of South Sylhet and Tipperah.	Ditto ...	...	Half-sheet super royal.	1	...	10	10	10	31 1 0	
REVENUE SURVEY MAPS.										
Map of Oudh, Revenue Survey, sheet No. 130 (2nd edition).	Drawn on transfer paper.	1 inch= 1 mile	Double royal	1	...	282	282	282	435 11 3	
Ditto ditto ditto, sheets Nos. 120, 139, 140, 146, 153, and 154 (2nd edition).	Ditto ...	Ditto ...	Ditto ...	6	...	...	...	...	2,553 0 4	Not to be printed.
Map of District Noacolly (in 12 sheets), sheets Nos. 1, 2, 4, 5, 6, 7, 10 and 11.	Ditto ...	Ditto ...	Ditto ...	8	...	...	...	...	2,192 15 11	Ditto.
Maps transferred from engraved sheets of the Atlas of India, &c.										
GENERAL MAPS.										
Map of Indian Atlas, full sheet, No. 40	Corrections and additions made.	1 inch= 4 miles	Antiquarian	1	...	...	...	...	105 12 0	Not yet printed.
Ditto ditto No. 41	Corrections and additions made and colour stone prepared.	Ditto ...	Ditto ...	1	150	75	225	555	325 4 8	
Ditto ditto No. 48	Additions of hills and corrections made.	Ditto ...	Ditto ...	1	...	200	200	200	465 6 0	
Ditto ditto No. 131	Additions of hills, corrections made, and colour stone prepared.	Ditto ...	Ditto ...	1	150	100	250	400	565 9 9	
Map of Indian Atlas, quarter sheet, Nos. 53 S. W. and 72 S. E.	Corrections made and colour stones prepared.	Ditto ...	Half-sheet Atlas.	2	200	200	400	700	118 13 0	
Ditto ditto ditto, No. 129 S. W.	Corrections, &c., made.	Ditto ...	Ditto ...	1	...	100	100	100	37 15 0	
Map of the locations of the Wuziri tribes on the British frontier.	Additions, corrections, &c., made.	Ditto ...	Half-sheet antiquarian.	1	...	400	400	400	252 8 0	
Map of Western Malwa Agency ...	Additions and corrections made.	1 inch=16 miles	Super royal	1	...	63	63	63	34 6 0	
Map of India, in 6 sheets ...	Hills drawn and additions and corrections, &c. made.	1 inch=32 miles	Double elephant.	6	...	...	...	...	2,625 8 7	Not yet printed.
DISTRICT MAPS.										
Map of District Cachar ...	Additions and corrections made and colour stones prepared.	1 inch=4 miles	Atlas ...	1	100	100	200	300	365 9 6	
Ditto Hazaribagh ...	Ditto ...	Ditto ...	Antiquarian	1	100	100	200	300	249 5 10	
Ditto Beerbhoom ...	Corrections and additions made.	Ditto ...	Imperial ...	1	...	...	...	..	54 13 8	Not yet printed.
Ditto Sonthal Pergunnahs	Ditto ...	Ditto ...	Atlas ...	1	...	...	...	...	87 6 0	Ditto.
Ditto Balaghat ...	Ditto ...	Ditto ...	Ditto ...	1	...	...	...	...	78 2 0	Ditto.
Maps, &c., drawn previously, but printed during the present year.										
REVENUE SURVEY MAPS.										
Map of District Maldah (in 7 sheets) sheet No. 6.	Corrections made.	1 inch= 1 mile	Double royal	1	...	282	282	282	145 7 11	
Map of Oudh Revenue Survey, sheets Nos. 100, 129, and 144, 2nd edition.	Ditto ..	Ditto ...	Ditto ...	3	...	846	846	846	462 5 6	
Map of District Julpaiguri (in 13 sheets), sheets Nos. 1 and 2.	Ditto ...	Ditto ...	Ditto ...	2	...	564	564	564	260 7 0	
Carried over ...	.....	.....	.....	51	700	3,984	4,634	6,264	13,431 1 1	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1880 AND 30TH SEPTEMBER 1881—*continued*.

Work done for the Survey Department.

DESCRIPTION OF MAPS.	Description of work done.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of coloured copies.	Number of uncoloured copies.	Total number of copies printed.	Number of impressions.	Value. Rs. A. P.	REMARKS
Brought forward ...	.....	.....	.....	51	700	3,984	4,684	6,264	13,431 1 1	
Maps, &c., transferred previously from the engraved sheets, but printed during the present year.										
GENERAL MAPS.										
Map of India (Atlas) full sheets, Nos. 68, 103, and 104.	Further corrections made, and colour stones prepared.	1 inch= 4 miles	Antiquarian	3	380	100	480	1,010	546 4 9	
DISTRICT MAPS.										
Map of District Mymensingh ...	Further corrections, &c., made.	1 inch 4 miles	Antiquarian	1	...	100	100	100	99 8 10	
Ditto Noakholly ...	Further corrections made, and colour stones prepared.	Ditto ...	Imperial ...	1	150	50	200	350	123 11 0	
Ditto Backergunge ...	Ditto ...	Ditto ...	Double royal	1	100	100	200	300	158 15 4	
Reprints.										
GENERAL MAPS.										
Map of India, (in 2 sheets), sheets Nos. 1 and 2.	.....	1 inch=64 miles	Double royal	2	...	50	50	100	44 3 0	
Map of Western Bengal, sheets Nos. 11 and 17.	.....	1 inch= 8 miles	Imperial ...	2	...	14	14	14	7 11 6	
Map of Western Bengal, sheet No. 15	Corrections, &c., made and colour stones prepared.	Ditto ..	Ditto ...	1	50	50	100	200	55 6 6	
Map of Eastern Bengal, sheets Nos. 1, 2, 3, 4, 5, 6, 7, and 9.	.....	Ditto ...	Ditto ...	8	...	205	205	205	67 4 8	
Map of Bengal, Behar, and Orissa...	.....	1 inch=32 miles	Double elephant.	1	...	10	10	10	6 1 0	
Map of Assam, sheet No. 6 ...	.....	1 inch= 8 miles	Imperial ...	1	...	52	52	52	9 12 6	
Map of India, No. 2A, 9th edition ...	Additions and corrections made and colour stones prepared.	1 inch=128 miles	Ditto ...	1	71	40	111	324	88 13 2	
Map of Assam (in 9 sheets), sheets Nos. 5, 7, and 8, 2nd edition.	Additions and corrections made.	1 inch 8 miles	Ditto ...	2	...	...	...	...	99 14 5	Not yet printed
Map of Eastern Bengal, sheet No. 8	Ditto ...	Ditto ...	Ditto ...	1	...	...	...	...	47 0 0	
INDEX MAPS.										
Index to the sheets of the Atlas of India.	Corrections made and colour stone prepared.	1 inch=128 miles	Imperial ...	1	150	50	200	350	75 3 0	
Index Map, No. 3 Party ...	.....	.....	Foolscap ...	1	...	20	20	20	3 4 0	
Small Index to the Indian Atlas ...	.....	.....	Ditto ...	1	...	200	200	200	13 2 10	
Index Maps, Nos. 1, 2, 5, 6, 7, 8, and 9 Parties, to accompany Annual Report.	Corrections and colour stones prepared.	.....	Ditto ...	6	2,400	300	2,700	3,500	418 7 8	
Index to the Indian Atlas showing the state of engraving to 1st October 1880, to accompany Annual Report.	Ditto ...	.....	Ditto ...	1	400	50	450	850	75 [illegible] 2	
Outline Map of India, showing the progress of the Imperial Survey up to 1st October 1880, to accompany Annual Report.	Ditto ..	inch=1.8 miles	Imperial ...	1	400	..	400	1,600	1.3 2 0	
PLANS.										
Plan of Calcutta ...	.....	3 inch 1 mile	Super royal	1	.	100	100	100	19 7 0	
Plan of Calcutta, in 2 sections ...	....	6 inch = 1 mile	Double elephant.	2	...	100	100	100	18 12 8	
Plan of City and environs of Calcutta, in 1 section.	.....	Ditto ..	40"×30" paper	4	...	100	100	400	71 1 0	
Guide plan of Simla and Jutogh ...	...	1 inch 1 mile	Imperial ...	1	...	54	54	10	10 1 6	
TOTAL ...	... ..	... .	.. ..	97	1 [illegible]	5,729	10,[illegible]	1,1 7	1 .. 2 9 7	
Physical specimens	...	...	.....	13	..	..	1,677	1,797	525 9 0	
Cadastral maps	..	.	.....	466	...	...	12 [illegible]	1..415	2,111 0 0	
Departmental forms	.....	.....	.....	43	.	...	21 [illegible]	31 [illegible]	[illegible] 3 3	
GRAND TOTAL ...	....	...	.	617	4, 01	5,729	46,30 [illegible]	611 7	2 [illegible] 5 10	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC BRANCH, SURVEYOR-GENERAL'S OFFICE, BETWEEN THE 1ST OCTOBER 1880 AND 30TH SEPTEMBER 1881—*concluded.*

Work done for other Departments.

NAMES OF DEPARTMENTS.	Number of maps.	Number of sheets.	Number of sheets coloured.	Number of sheets uncoloured.	Number of copies printed.	Number of impressions.	VALUE. Rs. A. P.
Foreign Department	34	34	...	34	3,101	2,700	1,237 9 2
Military Department	46	86	...	86	8,658	7,522	3,375 14 5
Home, Revenue, and Agricultural Department.	2	2	...	2	1,043	1,043	84 9 4
Telegraph Department	7	7	...	7	2,078	1,462	394 7 5
Bengal Office	26	26	19	7	21,577	12,184	982 14 3
Marine Survey Department ...	1	1	1	...	214	642	186 5 0
Sanitary Commissioner	1	1	1	...	985	3,000	377 5 1
Quarter Master General	40	40	...	40	2,954	2,242	211 5 4
Meteorological Reporter to the Government of India.	8	8	3	5	3,940	6,796	721 13 11
Archæological Survey of India ...	47	47	...	47	32,580	13,541	2,100 10 1
Geological Survey of India ...	9	9	7	2	8,535	24,361	2,407 1 6
Miscellaneous drawings	79	82	6	76	42,888	40,727	5,163 7 5
Maps, &c., drawn but not printed ...	20	37	2	35	...	...	735 8 3
TOTAL ...	320	380	39	341	135,553	116,820	17,978 15 2

Statement of type work executed, exclusive of transfers, &c., already included in the cost of the several Lithographic Maps, &c.

SUBJECT.	Items.	Number of copies.	Number of impressions.	VALUE. Rs. A. P.
Circular orders	10	1,795	2,414	91 5 0
Memoranda, &c.	373	142,198	204,855	4,321 7 0
Forms, &c., for Survey Department	45	67,099	192,799	3,731 3 0
Transfers of headings, foot-notes, reference to published maps for Photographic Branch.	860	8,082	8,082	1,184 2 0
TOTAL	1,288	219,174	408,150	9,328 1 0

General Abstract of out-turn and value of work performed.

DESCRIPTION OF MAPS.	Number of sheets.	Number of copies.	Number of impressions.	VALUE. Rs. A. P.
DEPARTMENTAL WORK.				
General and District maps, &c.	36	4,160	6,883	4,880 13 0
Index maps	13	4,042	8,592	798 2 10
Revenue Survey sheet maps, scale 1 inch=1 mile	7	1,974	1,974	1,303 15 8
Plans	8	354	1,008	418 6 2
Miscellaneous maps, &c.	13	1,677	1,797	525 9 0
Cadastral maps	466	12,415	12,415	2,114 0 0
Departmental forms	Items 43	21,683	31,518	3,004 3 3
Maps drawn but not printed	31	...	...	8,541 3 11
Total ...	617	46,305	64,187	21,586 5 10
Work done for other Departments	380	135,553	116,820	17,978 15 2
Total of drawing and printing in Lithographic Department ...	997	181,858	181,007	39,565 5 0
Work done in Type Department ... ... Items	1,288	219,174	408,150	9,328 1 0
TOTAL VALUE ...	...	...	...	48,893 6 0

Statement of Expenditure.

	Rs. A. P.
Establishment	31,557 13 7
Contingent charges	4,686 2 9
TOTAL ...	36,244 0 4

SURVEYOR-GENERAL'S OFFICE,
LITHOGRAPHIC BRANCH.
The 17th December 1881.

R. V. RIDDELL, *Major, R.E.,*
Assistant Surveyor-General,
In charge Lithographic Branch,
Surveyor-General's Office.

Extracts from Report of MAJOR S. H. COWAN, *Officiating Assistant Surveyor-General, in charge Photographic Branch, Surveyor-General's Office, season 1880-81.*

I have the honour to submit the usual tabular statements of work done, expenditure, &c., in this branch of your office during the Survey year from 1st October 1880 to 30th September 1881, *viz.*:—

A. Abstract of work performed in the Photographic Branch during 1880-81 (*printed in Part II*).

B. Comparative Statement of the out-turn of 1880-81 and of 1879-80.

C. Statement of expenditure during 1880-81.

D. Statement showing the value of work done for other departments during 1880-81.

E. Balance sheet for the financial year 1880-81, the value of cadastral maps being calculated at the rates sanctioned by the Government of India in February 1880, and the value of ordinary work by the scale drawn up by Major Waterhouse in November 1879.

The out-turn of office or ordinary work for the year under review is very much less than for the previous year; the falling-off has taken place in the miscellaneous departmental and in the extra departmental work, and is due to the slackening of the demand for maps of Afghanistan. The number of "pulls" was greatest in January and least in July. The cadastral out-turn is larger than last year's, and includes the first season's work of the Burma cadastral maps, of which 666 were received and photographed from October 1880 to January 1881: no more originals were available until July, when nine were photographed, and in August and September 425, and the demand from Burma for printed maps became so urgent that tracing by hand was resorted to, and 108 Burmah cadastral maps were zincographed in September. The system, commenced last year in the North-West Provinces, of congregating several small villages in one sheet, which was a great convenience to the executives, and saved much of the expense of publication, was discontinued in consequence of the objections of the Board of Revenue, North-Western Provinces, as noticed in last year's report, and only 73 villages separated by the re-transfer process are included in this year's out-turn. Instead of 25 copies of each North-Western Province cadastral map, the Board of Revenue has decided to take only 10 copies, of which 5 are to be on cloth and 5 on bank post.

The expenditure of the office during the survey year 1880-81 has been Rs. 89,560-2-10; for the previous year it was Rs. 1,01,067-6-7; the decrease is owing entirely to smaller receipts of chemicals and stores from England. The prices of absolute alcohol and sulphuric ether last sent out by the India Store Department are Re. 1-3-6 and Re. 1-4-3 per litre, as against Rs. 5-3 and Rs. 3 in 1880; and the collodion, which is made up here with these solvents by the Storekeeper, Mr. Caddy, costs Re. 1-14-1 per litre. Collodion was last imported in 1876, and then cost Rs. 9 per litre; and some small quantities, purchased locally this year for test and special work, cost Rs. 11-6-9. The annual consumption of collodion is about 700 litres, so that the saving on this item is at least Rs. 4,000 a year.

Comparative Statement of the Out-turn of 1880-81 with that of the previous year.

	ORDINARY WORK.				CADASTRAL MAPS, NORTH-WESTERN PROVINCES, BRITISH BURMAH, AND BENGAL			
	1st October 1880 to 30th September 1881.	1st October 1879 to 30th September 1880.	Difference.	Difference in square inches.	1st October 1880 to 30th September 1881.	1st October 1879 to 30th September 1880.	Difference.	Difference in square inches.
Originals	961	1,409	—448	...	4,591	3,673	+918	...
Negatives	1,278	1,928	—650	...	3,576	2,886	+690	...
Do. square inches	376,960	593,190	...	—216,230	2,741,776	2,216,448	...	+525,328
Photographic transfers	1,273	1,933	—660	...	3,762	3,115	+647	...
Do. sq. in.	391,808	595,970	...	—204,162	3,192,816	2,382,320	...	+800,496
Silver prints	558	1,028	—470	...	...	...	...	...
Do. square inches	97,418	111,064	...	—13,646	...	...	...	...
Transfers to zinc (No. of plates)	807	968	—161	...	4,705	3,661	+1,044	...
Number of pulls	84,546	125,150	—40,604	...	127,424	118,681	+8,743	...
Do. of printed sheets (single).	225,076	256,670	—31,594	...	127,424	118,681	+8,743	...
Ditto ditto (combined).	209,444	240,309	—30,865	...	83,102	64,031	+19,071	...
Proofs	927	1,283	—355	...	4,723	3,622	+1,101	...
Transfers	890	1,313	—423	...	4,760	...	...	...

PHOTOGRAPHIC OFFICE.

Statement of Expenditure of the Photographic Branch during the Survey year, from 1st October 1880 to 30th September 1881.

	Rs. A. P.	Rs. A. P.
Office Establishment.		
Superintendent's salary	10,200 0 0	
Establishment	25,947 1 6	
House-rent and taxes	4,485 7 6	
Contingencies	1,096 15 6	
		41,729 8 6
Cadastral Establishment.		
Establishment	23,941 0 5	
Contingencies	4,391 0 9	
		28,332 1 2
Chemicals and stores received from England	57,674 2 11	
Chemicals and stores received from Government Medical Store Department	68 6 2	
Stores and materials from other Government Departments	16 12 10	
Paper received	13,739 3 3	
		19,498 9 2
GRAND TOTAL		89,560 2 10

Statement showing the Amount and Value of the work done for other Departments and despatched between 1st October 1880 and 30th September 1881.

NAMES OF DEPARTMENTS.	Number of Sections.	Number of Negatives.	Number of Pulls.	Number of complete Copies	Number of silver prints.	PRICE. Rs. A. P.
Government of India, Foreign Department	2	5	160	185	42	183 13 9
Do. Do., Military Do.	61	57	2,362	2,698	...	1,353 11 10
Do. Do., Public Works Department, Irrigation Branch.	32	43	5,656	9,730	...	1,271 13 3
Government of Bengal	2	3	4,456	62,894	...	358 8 1
Do. Do., Public Works Department, Irrigation Branch.	24	39	1,140	50	...	326 9 0
Government of Bengal, Public Works Department.	5	22	2,075	620	...	714 15 3
Superintending Engineer, Central Circle, Bengal.	3	10	100	80	...	222 1 6
Government of Punjab, Public Works Department.	2	20	440	100	...	443 9 3
Government of North-Western Provinces and Oudh, Irrigation Branch.	83	97	1,470	3,297	...	1,270 9 7
Executive Engineer, Darjeeling Division	2	2	53	48	...	48 8 3
Quarter Master General in India	40	27	3,493	6,396	...	1,055 6 4
Inspector General of Military Works	105	39	7,070	6,930	...	2,999 11 6
Ordnance Department	4	4	...	2	3	37 8 0
Archæological Survey of India	5	2	712	3,560	...	156 6 6
Geological Survey of India	5	3	2,777	552	1	340 6 3
Director General of Garrison Instruction	3	2	340	475	...	66 14 9
Do. Do. of Telegraphs	2	2	...	...	64	46 11 0
Do. Do. of Railways	8	6	1,484	3,742	...	436 12 7
Manager, Tirhoot State Railway	31	...	1,090	2,080	...	331 1 6
Do. Rajputana State Railway	6	...	450	450	...	124 0 0
Eastern Bengal Railway	1	1	50	50	...	38 15 6
Meteorological Reporter to Government of India.	7	4	654	1,465	...	143 13 3
Settlement Officer, Hanthawaddy District	1	1	505	1,000	...	87 6 0
Do. Do., Bassein District.	1	...	205	200	...	21 9 3
Architect, Cooch Behar State	...	...	...	...	10	10 0 0
Chief Commissioner, British Burma	53	...	3,735	105	...	1,199 3 0
Asiatic Society	19	10	3,382	9,014	2	439 10 3
Marine Survey Department	18	47	4,560	3,270	...	1,857 14 0
Port Office	7	25	1,420	715	...	753 13 6
Mr. Beverley (Census, Calcutta)	1	1	...	1	...	13 12 0
Deputy Superintendent, Census, Burma	1	1	505	500	...	82 6 0
Mr. Sanderson, Superintendent of Kheddahs	16	17	...	...	126	162 8 0
Mr. Molesworth	2	1	...	2	6	17 13 0
Sergeant Gill	1	1	205	205	...	5 0 0
TOTAL	553	492	50,549	120,416	254	16,627 13 11
Cadastral, North-Western Provinces (Photo-zincographs.)	2,833	2,833	71,001	49,318	...	43,017 15 0
Cadastral, North-Western Provinces (Zinco-graphs and Re-transfers.)	835	...	22,700	22,700	...	9,224 8 0
Cadastral, Burma (Photozincographs)	828	828	28,153	8,770	...	13,403 4 0
Cadastral Burma (Zincographs)	49	...	1,666	952	...	548 3 0
TOTAL CADASTRAL	4,545	3,661	123,520	81,740	...	66,193 14 0
GRAND TOTAL	5,098	4,153	174,069	202,156	254	82,821 11 11

DR. *Photographic Branch Surveyor General's Office in Account with Government for the year, 1st April 1880 to 31st March 1881.* CR.

	Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
To estimated value of *Plant* on 1st April 1880	38,433 13 5		By estimated value of *Plant* on 31st March 1881	37,581 11 9	
,, ,, *Books, Tools, Furniture, &c.*	5,708 7 7		,, ,, ,, *Books, Tools, Furniture, &c.*	5,766 0 10	
,, ,, *Buildings, &c.*	7,503 4 6		,, ,, ,, *Buildings, &c.*	7,503 4 6	
		51,645 9 6	,, *Issue* of *Plant* to other Branches	553 4 6	
ADDITIONS TO *Plant*—					51,404 5 7
By receipt from Secretary of State, *Tools*	19 4 0		By *Stock* of *Chemicals* on 31st March 1881	10,480 11 2	
,, ,, ,, Mathematical Instrument Department, *Apparatus*	220 15 0		,, *Issue* of ,, to other Branches	51 5 3	
Miscellaneous	19 9 0				10,532 0 5
,, purchase—*Apparatus*, Rs. 45; *Books*, Rs. 27-8-3; *Tools*, Rs. 10-8	83 0 3		By *Stock* of *Glass* on 31st March 1881	27,615 8 0	
		342 12 3	By ,, of *Printing Materials* on 31st March 1881	2,473 15 5	27,615 8 0
To *Stock* of *Chemicals* on 1st April 1880	7,680 2 3		,, *Issue* of ,, ,, to other Branches	29 11 6	
Additions by receipt from Secretary of State	12,267 14 9				2,503 10 11
,, ,, ,, Medical Store	47 8 5		By *Stock* of *Printing Paper* on 31st March 1881	29,224 5 10	
,, ,, purchase	981 8 0		,, *Issue* of ,, ,, to other Branches	352 2 3	
		20,977 1 5			29,576 8 1
To *Stock of Glass* on 1st April 1880	25,880 14 0		By *Stock* of *Map Cloth* on 31st March 1881	517 8 5	
Additions by receipt from Secretary of State	3,235 0 0		,, *Issue* of ,, to other Branches	19 10 10	
		29,115 14 0			537 3 3
To *Stock* of *Printing Materials* on 1st April 1880	2,186 10 8		By ,, *Miscellaneous Stores* on 31st March 1881	1,456 0 3	
Additions by receipt from Secretary of State	1,008 13 8		,, *Issue* of *Miscellaneous Stores* to other Branches	66 4 0	
,, ,, ,, Medical Stores	88 13 9				1,522 4 3
,, ,, ,, other Branches	84 11 0				
,, ,, purchase	565 3 4		SALE OF UNSERVICEABLE STOCK—		
		3,934 4 5	Empty packing cases sent to Mathematical Instrument Department, &c.	95 1 0	
To *Stock* of *Printing Paper* on 1st April 1880	39,409 13 10				95 1 0
Additions by receipt from Secretary of State	282 2 8				
,, ,, ,, Stationery Office	4,114 14 6		WORK DONE—		
,, ,, ,, other Branches	268 2 6		Office Maps, Departmental	28,409 13 6	
		44,065 1 6	,, Extra Departmental	20,934 7 4	
To *Stock* of *Map Cloth* on 1st April 1880	37 3 0		Cadastral Maps	66,147 2 0	
Additions by receipt from Secretary of State	145 4 0				1,15,491 6 10
,, ,, ,, Stationery Office	525 0 0				
,, ,, ,, Surveyor General's Office	421 12 4				
,, ,, purchase	324 0 0				
		1,453 3 4			
To *Miscellaneous Stores* received from England	161 7 2				
,, ,, ,, purchased	38 14 0				
		200 5 2			
To *Repairs* by Mathematical Instrument Department	297 15 0				
,, *Stationery* for Office use	58 15 0				
,, *Paid* for Transfer traces	1,568 6 4				
,, *Colouring Maps* done in Surveyor General's Office	57 8 0				
		11,972 12 4			
To *Wages, &c.*, Officer in charge	10,200 0 0				
Office Establishment	26,449 6 3				
Cadastral ,,	22,220 3 3				
To *Contingent Expenditure* (not included above) Office	418 4 3				
,, ,, ,, Cadastral	570 10 6				
,, *House-rent* and *Taxes*	4,499 14 6				
		63,388 6 9			
To *Wear* and *Tear* on *Plant, &c.*, 10 per cent. on Rs. 45,000	4,500 0 0	4,500 0 0			
To *Profit* on the year's work	17,682 9 8	17,682 9 8			
TOTAL	2,39,278 0 4	2,39,278 0 4	TOTAL	2,39,278 0 4	2,39,278 0 4

S. H. COWAN, MAJOR, S. C.,
Officiating Assistant Surveyor General.

Extract from the Narrative Report of J. B. N. HENNESSEY, ESQ., M.A., *Deputy Superintendent 1st Grade, in charge Head-Quarters' Office, Trigonometrical Branch, Dehra Dun, for 1880-81.*

COMPUTING BRANCH.

The following cost-table of work done in the Computing Branch is similar to the corresponding tables exhibited in the reports for previous years :—

Calculating Branch.

Cost-table.

CLASSES.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
1. Records, Library	87	37	25	27	19	37	64	66	55	41	25	26	2
2. Computations	505	517	409	428	505	387	383	535	522	454	431	427	22
3. Accounts, Returns, Correspondence	280	206	422	262	148	213	363	404	328	365	429	476	15
4. Supply	68	51	42	54	47	47	24	33	85	21	42	23	2
5. Press copy	239	283	114	369	475	449	127	197	306	472	301	403	14
6. Press proofs	326	256	191	177	238	233	229	242	242	220	283	230	11
7. Charts	16	45	30	40	26	9	2	33	111	74	...	11	1½
8. Stations	44	92	43	47	167	146	95	66	131	114	113	128	4½
9. Leave, Holiday	211	288	558	495	269	428	485	214	92	112	191	110	14
10. Miscellaneous	349	350	291	226	231	179	363	335	251	252	280	291	13
TOTAL	2,125	2,125	2,125	2,125	2,125	2,125	2,125	2,125	2,125	2,125	2,125	2,125	100

Classes 2 and 5, being intimately connected, have always been considered in combination: they collectively indicate a percentage of 36, which was also their percentage last year. Similarly the other classes present very nearly the same percentages as in 1878-79 and 1879-80.

The particulars of the work indicated in a general manner in the preceding table are given hereafter in such detail as appears desirable.

Class 2.—Computations—

Principal Triangulation (in duplicate).

SOUTHERN TRIGON.—Principal triangles, computed 267
" (traverse) latitudes, longitudes, and azimuths, computed . 275
" (original field) " " corrected . 7

Final weights (to be used in the simultaneous reduction)—well advanced towards completion.

Working charts prepared for simultaneous reduction.

Co-efficients of x, y, z, expressed analytically, and the equations of condition written out; absolute terms found for these equations; b, cs calculated for the side equations, and μ ϕs for the other equations; and forms prepared for further stages of the reduction.

EASTERN FRONTIER SERIES SOUTH OF 23°.—Reduced 10 quadrilaterals, and extended computation from 2 to 3 places of decimals in 3 single and 3 compound figures.

Secondary Triangulation (in duplicate).

N. W. QUADRILATERAL AND N. E. QUADRILATERAL.	Traverses, computed	10
	Triangles, computed and adjusted	800
Chiefly Jodhpur Series and Kumaun and Garhwal Triangulation.	Latitudes, longitudes and azimuths, computed	416
	Auxiliary azimuths, computed	800

AFGHANISTAN AND BELUCHISTAN TRIANGULATION.	Triangles, computed	20	NOTE.—These computations occupied a pair of computors over half a month.
	Ditto feet and miles, computed	200	
	Auxiliary figures, computed	1	
	Spherical excesses, computed	3	
	Latitudes, longitudes and azimuths, computed	3	
	Azimuth and side (from latitude, longitude as data) computed	15	

Principal and Secondary Triangulation (not in duplicate).

Eastern Sind Series, Madras Coast Series, and Malabar Minor Series. (Computed under Colonel B. R. Branfill.)	Principal triangles, computed	43	Note.—These computations occupied a computor over four months.
	Compound figures, „	2	
	Simple „ „	4	
	Spherical excesses „	38	
	Principal latitudes, longitudes and azimuths, computed	74	
	Principal heights, computed	73	
	Azimuths by circumpolar star observations, computed	1	
	Weights, computed	65	
	Secondary triangles, computed	122	
	Ditto latitudes, longitudes and azimuths, computed	206	
	Ditto heights computed	206	
	Besides preparing synopses of results, abstracting angles, horizontal and vertical; &c. &c.		

In addition to the foregoing the following computations, &c., have also been performed :—

Observed latitudes.—Good progress has been made in these reductions, at the same time that it is difficult to exhibit the amount of work done. The Δ table (*i. e.*, north polar distance) was completed in respect to precession, secular variation and proper motion, after which these quantities were carefully verified, and it need hardly be said that the proper motions alone afforded subject for careful consideration. The precessions for the 906 stars were then computed for the required epoch (1850), it being found necessary in about one-fourth the number to re-compute from the original elements. The several epochal values of Δ, and for each star the mean Δ and $\delta\ \Delta$ were next determined, after which the whole tabulation for the 906 stars was carefully considered and discussed. This led to the adoption of a large number of the Δs already found, but it also brought to light that further search was necessary in very many cases, where the results obtained were made up of discordant values or were otherwise unsatisfactory; eventually the Δs for about 800 stars were fixed, and from these the sub-epochal values, *i.e.*, for years of observation, have been computed.

S. W. Quadrilateral.—To meet immediate wants, the trigonometrical heights of Bombay longitudinal, Khánpisura, Singi, and a portion of Guzerat longitudinal series have been provisionally adjusted between spirit-leveled points.

Electro-Telegraphic Longitudes.—Various calculations made for portions of the press copy on this subject.

Volumes VII and VIII.—Several tables compiled and computed for incorporation in the account of the reduction of the North-East Quadrilateral.

Spirit-leveled Sections, *Bombay, Bider, Bangalore, Madras, &c.*—These sections exhibited certain peculiar anomalies which do not readily admit of explanation here; nor is this necessary as they have been discussed in a separate paper. The sectional values were made consistent by the method of least squares. This admitted of determining corrected heights and lengths of the Bangalore, Bider, and Cape Comorin base lines, which was done.

Borghât Section.—The transverse section of this ridge presents a precipitous fall to the west and a gradual incline eastwards, conditions which may affect spirit-leveling. It was, however, shown by calculation that the influence of the Borghât section was insensible on the spirit-leveled sections above mentioned.

Auxiliary Table XXXVI.—For finding length and azimuth of a side from the latitude and longitude of its extremities, computed.

Latitude observations at Mergui base line.—Thirteen pairs of suitable stars were found for this work, and their places determined for two different periods of observation.

Class 3.—Accounts, Returns, Correspondence.—The designation of this class is more general than special to avoid undesirable increase of the adopted number of classes. The work represented is almost entirely professional in nature, at the same time that it presents considerable variety in kind. It is only the residue of this class that may be prepared by an ordinary clerk.

Class 4.—Supply.—Requisitions from thirty officers for data of various kinds complied with: in two or three instances this involved a considerable amount of work: 1,160 despatches of forms, maps, charts, books, &c., were made during the year.

Class 5.—Press Copy.—

S. E. Quadrilateral.—Synoptical Volumes X, XII and XIII.—Completed in respect to errata, contents, references, &c.

N. E. Quadrilateral.—Kumaun and Garhwal Series.—Compiled descriptions of secondary stations (in part).

Bidhon, Rangir, Amúa, and Karára Series.—Introductions recast or written.

Ourwáni, Oora, and Chendwár Series.—Introductions critically examined.

Volumes VII and VIII.—Introductory account of final grinding continued.

The introductory narrative accounts for the series of the N. E. Quadrilateral require notice. Such introductions were wanting for all the series, and the demand was difficult to meet, because some of the work having been executed about half a century back, it became a tedious and painstaking task to search for and collect the incidents attendant on each triangulation. Eventually, the work was begun by Mr. C. Wood who compiled four of the introductions

At this stage Colonel B. R. Branfill and the Surveyor General himself were good enough to co-operate—

N. W. Quadrilateral.—Jodhpur Series.—Principal and secondary triangles, azimuth table, and co-ordinate lists prepared (two latter want re-comparison).

Southern Trigon.—Alphabetical and numerical lists of principal stations completed.

Facts collected for descriptions of principal stations; and orthography examined and determined for several of the names occurring in these descriptions.

Reduction of figures completed and compared.

Tables of "sums of squares" and E. M. S. table completed and compared.

Abstracts of observed angles partly compared.

Circuit and non-circuit triangles copied for entire trigon.

Volume X, or Electro-Longitude Volume.—A good deal of transcription and examination done of press copy before sending to printer.

Eastern Frontier Series, South of 23°.—Abstract of angles continued, and tables of "sums of squares" and reduction of figures prepared (in part).

Miscellaneous.—Spirit-leveled heights, Bombay Presidency—

No. 1.—Errata examined and partly compared.
No. 2.—Errata *et* corrigenda prepared.
No. 3.—Examined generally and corrected.

Madras Coast Series (1879-80) preliminary numerical chart. Letter press supplemented where deficient, and the whole compared.

Beluchistan Series (1877-79) preliminary numerical chart. Prepared letter press.

Tables for the reduction of meteorological observations transcribed.

Memorandum and form prepared for readily calculating the length and azimuth of a side from the latitude and longitude of its extremities.

Class 7.—Charts—

Final . { Compared Huriláong and Ourwáni Series. Corrections examined in Chendwár and Karára Series, and in reduction chart of N. E. Quadrilateral.

Preliminary . { Compared Kandahar Series, season 1878-79. Ditto Beluchistan Series, „ 1877-79. Ditto Malabar Minor Series, „ 1879-80.

Rough working chart of southern trigon completed and compared.

Khánpisura Series (south portion), MS. chart examined.

Index chart of the triangulation of India, specially prepared for Venice Exhibition.

Assam valley triangulation (1876-78) preliminary chart drawn by field parties; examined generally, and directions issued for fair drawing.

Besides, several charts examined either in detail or in a general manner.

Class 8.—Stations.—This class shows a small increase in the percentage of the present year as compared with that of previous years. This is due to the circumstance that the bills for the protection of stations are now audited and passed in this office, where the important work of protecting the principal stations is controlled. Of additional duplicate lists, 2 have been completed during the year, making a total of 339 district lists, including 3,293 principal stations and two supplementary lists descriptive of 20 stations issued to district officers.

Class 10.—Miscellaneous.—For Volumes IX and X of observed latitudes and of electro-telegraphic longitudes, read critically and discussed a considerable amount of descriptive letter press written by Colonel W. M. Campbell, R.E.; also examined, corrected and completed a number of illustrative drawings of Strange's zenith sector, &c., and passed them for engraving; examined and reported on; (1) trigonometrical heights of some stations South-West Quadrilateral to be determined from spirit-leveled points; (2) certain anomalies in spirit-leveled sections, Southern India, and the influence on them of the Borghât on the Sahyadri range. Meteorological observations taken at Dehra twice on every day of the year, and at Mussooree for about 7 months; the results for Dehra supplied to the Meteorological Reporter to the Government, North-Western Provinces; and daily weather telegrams for Mussooree, as well as the anemograms for both Dehra and Mussooree, supplied to the Meteorological Reporter to the Government of India.

Earth Thermometers.—Mention may be suitably made here of certain earth thermometer readings which have been taken daily at this office since May last. Readings of the kind are well known. Amongst others, there are the excellent series at the Royal Observatory, Edinburgh, commenced by Professor J. D. Forbes in 1837 and continued by Professor Piazzi Smyth, and the series at the Royal Observatory, Greenwich, begun in 1847, and subsequently continued by Sir George Airy. In these instances the mechanical skill that was available readily provided satisfactory and convenient arrangements. Thus, at Greenwich, the greatest depth required being 25·6 feet, a suitable narrow hole was dug and the first thermometer bulb placed at that depth, while the stem of the thermometer reached up to a convenient height above ground for reading: the whole was then filled up to a depth of 12·6 feet, where the next thermometer bulb was placed; and so on for the others. Thus, all the thermometers stand in *one* hole, and all their stems appear together above ground, when they are read comfortably. In India, however, while the magnitude of measurable solar energy presents highly favourable conditions for measurement, the practical requirements are difficult of attainment or out of reach. For instance, thermometer stems, some 28 feet long, of glass, would be sure to get broken in transit, and even to dig a hole, say 6 or 8 inches square, and some 26 feet deep, involves a feat which nobody would willingly incur twice, when his implements are limited to

a *continuous* iron jumper for smashing the boulders encountered, and only a green bamboo split at the end to grip and bring to surface the broken stones. At any rate, these were all the implements available here, and it is very creditable to the Natives employed that their patience was equal to the occasion. The holes dug here are 6 to 8 inches square at surface, though no doubt their sections below are some inches larger than this as well as irregular: in depth, there are two holes of 1·1 foot, two of 3·2 feet, two of 6·4 feet, one of 12·8 feet, and one of 25·6 feet; the thermometer bulbs are suspended or placed at these depths, and the instruments are drawn up to be read and then let down to their places; after this the holes are plugged and covered with tin caps. Other precautions also are taken to ensure that no surface drainage runs into the holes, which have proved, so to speak, watertight, except the 26 feet hole; into this hole there have been two or three subterraneous discharges of puddle, occurring when a mountain stream passing some half a mile to the east is in flood. The discharges, however, have not been very serious, but, such as they were, no ready method presents itself for stopping them. The mercurial thermometers employed are excellent of their kind, but they are only about 14 inches in length: they are enclosed in glass tubes; for present purposes, the bulb ends are fitted into copper boxes and are otherwise protected, so that when the instrument is raised to the surface the readings remain constant during ample time for noting them. It would be premature to enter on any discussion of the results at present, but it may be interesting to notice that *maximum* temperature occurred as follows:—In the 6·4 feet hole about 20th September; in the 12·8 feet hole about 15th October; and in the 25·6 feet hole about 15th November.

Typographic Branch.

The work annually performed by this branch during the past 5 years is briefly given in the following table, where the unit (a page of foolscap) is the same throughout:—

	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
Pages composed	1,535	2,050	1,844	1,421	1,363
„ printed	495,573	630,894	590,043	494,136	480,672

An analysis of the pages composed furnishes the following:—

	Pages.		Pages.
For professional Volumes VII and VIII . .	406	For Synoptical Volumes X to XIII . .	43
„ „ „ X	480	„ „ „ of N. E. Quadrilateral	12
„ „ „ of S. W. Quadrilateral and Southern Trigon	60	„ „ „ Jodhpore series . .	4
Total . .	946	Total . .	59

	Pages.
For auxiliary tables	9
„ spirit-leveled heights, No. 3, Bombay Presidency	54
„ charts, orders, memos., forms, &c.	295
Total . .	358

Photozincographic Branch.

The following are the details of the work executed by the Photozincographing Branch during the year:—

MAPS.

Subject.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	....	115	7,096
Sketch map of route from Simla, *viâ* Dagshai and Nahan to Dehra Dun	October 1880 .	1	5
Index to Cutch survey	„ „ .	1	449
Kumaun and Garhwal *forest* map, sheet No. LV (*for Forest Department*)	„ „ .	1	68
Sketch map of Sakkar to Quetta	November „ .	1	8
Map of Western India, illustrating generally the Viceroy's autumn tour in 1880	„ „ .	1	11
Guzerat survey, sheet No. 26	„ „ .	1	15
Index to Guzerat survey	„ „ .	1	512
Ditto Kattywar survey	„ „ .	1	462
Kumaun and Garhwal *forest* map, sheet LIV (*for Forest Department*)	„ „ .	1	47
Ditto ditto ditto LXIV ditto . .	December „ .	1	66
Gilgit and surrounding country (rough map)	January 1881 .	1	23
Index to the level charts	„ „ .	1	436
Patli Dún hill forests (*for Forest Department*)	February „ .	1	520
Sketch map of forest reserves in Pegu and Tenasserim Divisions of British Burma (*for Forest Department*)	„ „ .	1	520
Guzerat survey, sheet No. 26, section 1	„ „ .	1	86

MAPS—*continued.*

Subject.	When published.	Number of parts.	Number of sheets printed.
Guzerat survey, sheet No. 26, section 2	February 1881...	1	88
Ditto ditto ditto 3	,, ,, ...	1	85
New map of Gilgit and surrounding country	March ,, ...	1	168
Guzerat survey, sheet No. 25, section 1	,, ,, ...	1	87
Ditto ditto ditto 2	,, ,, ...	1	86
Ditto ditto ditto 3	,, ,, ...	1	85
Cutch survey, sheet No. 22	,, ,, ...	1	130
Guzerat survey, sheet No. 25, section 4	April ,, ...	1	87
Ditto ditto 15, ditto 1	,, ,, ...	1	85
Ditto ditto 15, ditto 2	,, ,, ...	1	87
Ditto ditto 32, ditto 2	,, ,, ...	1	87
Ditto ditto 49, ditto 10	,, ,, ...	1	90
Cutch survey, sheet No. 15	,, ,, ...	1	126
Ditto ditto 12	May ...	1	130
Guzerat survey, sheet No. 50, section 3	,, ,, ...	1	86
Turkestan map, sheet No. 1 (5th edition)	,, ,, ...	1	675
Ditto ditto 2 ditto	July ,, ...	1	263
Ditto ditto 3 ditto	,, ,, ...	1	178
Ditto ditto 4 ditto	,, ,, ...	1	15
Debra Dún old cantonment, sheet No. 2 (*for Dehra Municipality*).	,, ,, ...	1	47
Northern Waziristan and the Dawar Valley	,, ,, ...	1	156
Sketch reconnaissance of country west of Waziristan	,, ,, ...	1	19
Survey of Upper Meranzai	,, ,, ...	1	216
Reconnaissance of Bar Mahomed, Shai Khan, Mamozai, Rabiakhel, and Sipai country, and portion of Tirah	,, ,, ...	1	168
Guzerat survey, sheet No. 16, section 1	,, ,, ...	1	85
Military map of India (*for Quartermaster-General's Department*)	,, ,, ...	1	11
Part of the Mahsud Waziri country	August 1881 ...	1	164
Survey of portion of Lower Meranzai	,, ,, ...	1	126
Sketch map of the Kotlia road and branches (*for Forest Department*)	,, ,, ...	1	468
Guzetat survey, sheets Nos. 5 and 24 conjointly	,, ,, ...	1	88
Ditto sheet No. 16, section 2	,, ,, ...	1	88
Ditto ditto 50, ditto 2	,, ,, ...	1	89
Ditto ditto 50, ditto 4	,, ,, ...	1	84
Reserved forests, Kheri and Pilibhit (*for Forest Department*).	September ,, ...	1	615
Ditto Bahraich *ditto*	,, ,, ...	1	282
TOTAL	.....	165	15,659

Besides the foregoing, 414 blue prints and 52 silver prints (13 subjects) were prepared for the use of executive officers.

CHARTS.

Subject.		When published.	Number of parts.	Number of copies printed.
Kelat series, season 1879-80	Preliminary	October 1880 .	1	130
Chart illustrating triangulation in Kattywar, Degree No. X	Not for issue	,, ,, .	1	8
Chart illustrating triangulation in Kattywar, Degree No. XII	Not for issue	,, ,, .	1	18
Chart illustrating triangulation in Kattywar, Degree No. XIII	Not for issue	,, ,, .	1	18
Kandahar series, season 1878-79	Preliminary	Nov. ,, .	1	127
Southern Trigon triangulation	*For office use*	January 1881 .	2	23
Chart of triangulation around Chakrata	Rough	February ,, .	1	25
Reduction Chart of the Jodhpur Meridional series	Final	,, ,, .	1	320
Gurwáne Meridional series	,,	March ,, .	1	380
Beluchistan series, seasons 1877-79	Preliminary	April ,, .	2	106
Chart illustrating triangulation in Kattywar, Degree No. III.		,, ,, .	1	35
Reduction chart of North-East Quadrilateral	Final	,, ,, .	1	625
Madras coast series, with Negapatam minor series, season 1879-80	Preliminary	August ,, .	1	71
TOTAL		...	15	1,886

DIAGRAMS.

Subject.	When published.	Number of copies printed.
Polygons and other figures to illustrate figural reductions for volumes of the Great Trignometrical Survey Bench-marks, &c.	.....	3,367
Professional and Office Forms	1880-81	19,508

The total number of negatives taken is 616; the number of chromo-carbon prints 661; and the number of transfers to zinc, 186.

Contrasting the work performed since 1876-77, we have—

Year.	Maps.	Blue-prints.	Silver-prints.	Charts.	Diagrams.	Forms, &c.
1876-77	12,348	108	189	9,225	3,956	21,384
1877-78	12,481	195	426	4,531	4,877	23,736
1878-79	20,229	1,394	353	2,642	2,603	20,070
1879-80	15,100	588	1,021	3,821	3,271	17,909
1880-81	15,659	414	52	1,886	3,367	19,508

An abstract of the work executed during the past five years stands thus:—

Subject.	Number of Prints.				
	1876-77.	1877-78.	1878-79.	1879-80.	1880-81.
Maps, charts, and diagrams	25,529	21,889	25,474	21,192	20,912
Blue-prints	108	195	1,394	588	414
Silver-prints	189	426	353	1,021	52
Forms, &c.	21,384	23,736	20,070	17,909	19,508

The money actually realized and credited to Government from sales of maps, &c., during the year is Rs. 1,051-10-6.

Drawing Branch.

The following tables exhibit the work performed in this Branch:—

Description of Work.	Number of sheets or Diagrams.		Scale, one inch = miles.	Remarks.
	Finished.	In hand.		
Final Charts.				
Huriláong meridional series	1	...	4	For reduction by photo-zincography.
Brahmaputra series	...	1	4	
East Calcutta longitudinal series	...	1	4	
Eastern Frontier series	...	1	4	
Preliminary Numerical Charts.				
Beluchistan series, seasons 1877—79	1	...	4	For reproduction on full scale by photo-zincography.
Madras Coast series, with Negapatam minor series, season 1879-80	1	...	4	
Malabar minor series, with Colonel Lambton's connection, season 1879-80	1	...	4	
Assam Valley triángulation, seasons 1876—78	...	2	4	
Compilation.				
Turkestan map, sheets Nos. 1, 2, 3, and 4 (5th edition)	4	...	32	For photo-zincography.
Spirit-leveled height charts, sheets Nos. 67, 75,* 81, 82,* 83 and 88	2*	4	2	
Sketch map of route from Simla, *viâ* Dagshai and Nahan to Dehra Dún	1	...	2	
Sketch map of Sakkar to Quetta	1	...	4	
Map of Western India, illustrating generally the Viceroy's autumn tour in 1880	1	...	32	
New map of Gilgit and surrounding country	1	...	4	
Map of Dehra Old Cantonment, for Dehra Municipality, sheets 1 and 2	2	...	Feet. 66 Mile. 1	
Map of Jaunsar Bawar	...	1		
Atlas reductions of sheets 2 and 3, Dehra Dún and Siwalik Survey	...	2	Atlas scale.	For incorporation in atlas sheets.
Levels in the Sind Saugor Doab, Derajat Circle	Sections. 4	...	2	For incorporation in level sheets.
Rough map of country between Chitral and Yassin	1	...	12	For incorporation in Turkestan map.
Revised, corrected, and enlarged route map of Western Himalayas, Punjab, &c.	1	...	32	For engravers.

Description of Work.	Number of sheets or Diagrams.		Scale one inch = miles.	Remarks.
	Finished.	In hand.		
Miscellaneous.				
Prepared a copy of rough map of country between Chitral and Yassin, for Surveyor-General's Office, Calcutta	1	...	12	
Prepared a trace of a new map of Gilgit and surrounding country for Colonel Tanner	1	...	4	
Prepared outline map of Gilgit and surrounding country for Colonel Tanner	1	...	4	
Prepared a trace of levels falling in level sheet No. 20 for Executive Engineer, Cawnpore	1	...	2	
Tabulated level data in Oudh (Sardah Canal) for Assistant Secretary to Government, North-Western Provinces	...	...	...	
Prepared a trace of map showing boundaries of North-Western Frontier Tribes	...	...	...	
Prepared descriptions of bench-marks for level sheets 75 and 82	...	...	...	
Drew diagrams of bench-marks for level sheets 75 and 82	111	...	...	
Prepared rough chart of triangulation around Chakrata for Colonel DePree	1	...	½	
Prepared rough charts of Southern Trigon, Nos. 1 and 2	2	...	20	For photo-zincography.
Typed names in, and completed, plan of Kabul and its environs, No. 2, by Mr. McNair	1	...	¼	Forwarded to Calcutta Office for publication.
Typed names in, and completed, map of part of road from Kandahar to Kabul, by Lieutenant St. G. C. Gore	1	...	4	
Plotted points on, and otherwise completed index map to Northern Afghanistan Field Surveys, season 1879-80	1	...	8	
Marked boundaries on 2 sets of Southern Trigon charts, showing the different languages spoken in Southern India	...	...	...	
Prepared scales for solar spots	...	...	...	
Corrected to date 11 copies of index chart to the triangulation of India, showing arcs of longitude, tidal stations, &c.	11	...	96	For Engravers, the Venice Exhibition, and use of officers.
Copied descriptions of bench-marks in Dera Ghazi Khan District	...	...	...	
Computed areas of Dehra and Mussooree Municipal limits, Landour Cantonment, &c., for census authorities	...	...	...	
Prepared forms, professional and others	21	...	...	
Examined, corrected, and passed for the press, original maps of topographical surveys	28	...	various scales.	
Examined and passed for the press, proofs of maps and charts, &c.	170	...	ditto	
Coloured 7,699 maps	...	...	...	
Completed the new list of maps and charts in the Drawing Office	...	...	...	
Miscellaneous current duties, including preparing for the press several forest survey maps, transliterating Russian names, reducing maps by pantograph, and affording assistance to officers; also, preparation of special information on maps required for the visit of the Viceroy and Governor General in November last	...	...	...	

Several of these drawings present subjects of no ordinary interest and utility: a few of them are selected for brief notice.

Beluchistan Series.—This chart exhibits an excellent series of triangles about 200 miles in length, penetrating to Quetta; other series dependent on this one have been carried down to Khelat and up to somewhat beyond Kandahar—places which now possess the novelty of accurately determined trigonometrical points whose latitudes, longitudes, and heights stand well-determined.

Turkestan.—The present is the 5th edition of this map. It exhibits all our knowledge of Afghanistan derived in course of the recent campaigns, and besides including various improvements from other sources, it has enjoyed, like its predecessors, the advantages of compilation under the Surveyor-General's personal directions.

Spirit-Leveled Height Charts.—They exhibit, not only the main lines determined by the survey, but also every available branch contribution from other departments; work of the latter kind, having served its immediate purpose, would in course of time be absolutely lost but for these compilations, which in their way are representatives of the conservation of energy.

Route Map, Western Himalayas.—In a further edition, now being engraved, of the original map devised by the late Colonel T. G. Montgomerie, R.E., a work for which there is a standing annual demand.

New Map of Gilgit.—Includes some terribly rugged and utterly desolate regions as well as the comparatively populated valleys of the Indus and its tributaries, all of which jut out in the peculiar Gilgit-wedge on the north-west frontier of Kashmir. The work was done

by Colonel H. C. B. Tanner, during whose necessary absence on political duty the map was compiled in this office.

MISCELLANEOUS.—Exhibit a variety not without interest. All spirit-leveled data available was in eager demand for the Sardah Canal—a project which, it is hoped, will in time contribute to the extension of our charts.

CORRESPONDENCE AND STORES.—The year's correspondence is represented by 1,990 letters and office memos. (dockets), the ratio of the former to the latter being sensibly greater this year than in 1879-80. As regards instruments, &c., received and despatched, there were of—

Instruments despatched	202
Ditto received	280
Stores, articles received	353
Do. do. despatched	50

presenting a total of 295 parcels and packages received, and of 124 packages issued.

SOLAR PHOTOGRAPHY.

Mr. L. H. Clarke, Surveyor, 2nd Grade, has continued to officiate as Solar Photographer. The period under review comprises 365 days, of which the working facts are tabulated below :—

1880-81.	NUMBER OF DAYS.				NUMBER OF NEGATIVES.						NUMBER OF WORKING DAYS WHEN SOLAR PHENOMENA WERE	
	When negatives were taken.	FAILURES.			SOLAR PHENOMENA.							
		From bad weather.	From various causes.	TOTAL.	Spots and faculæ.	Spots only.	Faculæ only.	None.	RUNS.	TOTAL.	Visible.	Absent.
October	30	...	1	31	21	35	...	2	24	82	29	1
November	26	2	2	30	12	26	...	13	22	73	19	7
December	25	6	...	31	16	31	...	...	19	66	25	...
January	29	2	...	31	25	23	2	1	23	74	28	1
February	27	1	...	28	36	10	...	1	9	56	26	1
March	26	5	...	31	41	...	...	...	7	48	26	...
April	27	3	...	30	47	3	...	...	...	50	27	...
May	29	2	...	31	52	2	...	2	4	60	28	1
June	23	7	...	30	49	5	...	...	6	60	23	...
July	15	16	...	31	40	...	...	...	5	45	15	...
August	25	6	...	31	63	...	...	3	10	76	24	1
September	25	5	...	30	72	...	...	...	21	93	25	...
TOTAL	307	55	3	365	474	135	2	22	150	783	295	12

The table shows that during the period of 365 days the sun was photographed on 307 days, and 633 negatives, besides 150 runs, obtained; also, that on 295 of the 307 working days solar features were present.

The following percentages are found from this table and from similar tables given in preceding reports :—

First, as regards the numbers of days when the sun was invisible from bad weather—

In 1877-78, the sun was invisible on	9	in	100	days	(obtained from	273	days)
„ 1878-79,	„	„	11	„ 100	„ (	„	89	„)
„ 1879-80,	„	„	14	„ 100	„ (	„	289	„)
„ 1880-81,	„	„	15	„ 100	„ (	„	365	„)

whereas at Greenwich, for the period 9th May 1880 to 13th May 1881, the sun was visible on only 149 days, which gives 60 per cent. of invisibility against but 15 at Dehra Dún.

Again, as regards the presence of solar features on working days, we have—

In 1877-78, features present on	30	in	100	working days	(obtained from	248	working days)
„ 1878-79,	„	„	28	„ 100	„ (	„	79	„)
„ 1879-80,	„	„	82	„ 100	„ (	„	232	„)
„ 1880-81,	„	„	96	„ 100	„ (	„	307	„)

The Greenwich results for 9th May 1880 to 13th May 1881 give a percentage of 98 corresponding to 96 at Dehra Dún, which is a sufficiently close agreement, considering that the twelve-month has different terminals at the two Observatories.

The percentages above given show a marked increase in so-called "solar activity." To this may be added that the bright features or faculæ have been very abundant.

In addition to the negatives, 1,352 silver prints were made from them. The negatives and prints were despatched weekly, as required, to the India Office, London, for transmission to the Solar Physics Committee, South Kensington.

A sunshine recorder has been set up. It consists of Mr. Campbell's glass sphere, with the card supporter and other improvements introduced by Professor Stokes, whereby the recorder has been converted into an effective instrument, acting with precision and certainty.

A sudden outburst of sun spots occurred in the sun on 25th July 1881: the particulars of this event have been communicated to the Asiatic Society of Bengal, and to the Journal of Science called Nature, so that merely a brief statement need be made here.

The day named was dark and cloudy: no solar negative could be taken till 3-58 P. M., when No. 1175 was secured through a cloud opening. While watching for further opportunity, another cloud-break occurred; the sun's image was *seen as usual on the ground glass for focusing*, when Mr. Clarke now also saw, at about 4-35 P.M., a considerable group of *new* spots near the sun's centre. This event induced him to persevere, and he succeeded in obtaining at 4-47 negative No. 1176, in which the new group is exhibited. The group consisted of 16 spots not far apart, yet scattered over some 6,000 millions of square miles, the collective area of the spots themselves is estimated at 630 millions of square miles, or, say, six times the area presented by the earth to the sun. The time of the occurrence is known within limits unusually small for events of this nature, *i.e.*, within the 37 minutes following 3-58 P.M. local apparent time. No other negatives could be obtained the same day, nor was the sun again visible till July 30th, when the group had disappeared: two other spots were now visible; of these, one alone covered the enormous area of more than 900 millions of square miles.

My description of the outburst has been obligingly noticed by other observers, none of whom however saw the sun on 25th July 1881, nor till the day following; the new group of spots was not seen by any other observer, so far as I am at present informed.

Monthly Meteorological results taken from the Register kept at the Head-quarters' Office, Trigonometrical Branch, Survey of India, Dehra Dún.

YEAR AND MONTH.	BAROMETER.						HYGROMETER.				THERMOMETER.								RAIN.		WIND.	CLOUD.	
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.		At 3-30 P.M.		Dry Bulb.					Wet Bulb.							
	Highest.	Lowest.	Monthly Mean.	Highest.	Lowest.	Monthly Mean.	Monthly Mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point	Monthly mean humidity.	Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum wet.	Minimum wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
1880.																							
October	27·823	27·634	27·722	27·756	27·511	27·632	60·2	·614	61·8	·518	106·3	46·0	87·2	54·0	72·6	77·1	48·2	63·5	...	...	N. N. E.	1	2
November	·945	·785	·840	·839	·685	·752	51·2	·673	52·3	·522	103·0	39·0	80·7	45·6	62·4	66·4	42·3	54·6	1	1·47	...	2	2
December	·897	·750	·823	·814	·644	·748	48·0	·793	48·6	·599	89·5	34·7	70·5	40·6	55·2	61·3	33·0	49·5	4	1·62	W. S. W.	3	4
1881.																							
January	·953	·741	·839	·879	·683	·761	43·8	·707	43·4	·440	86·1	30·2	71·6	37·1	54·8	62·2	36·0	47·9	1	·26	N. N. E.	1	1
February	28·019	·708	·796	·836	·655	·716	46·4	·615	45·4	·409	93·0	34·2	77·7	42·1	60·9	63·0	37·6	52·0	4	·64	...	4	6
March	27·846	·545	·714	·775	·496	·643	52·8	·677	51·9	·519	99·2	38·8	82·6	43·3	63·8	68·5	41·2	55·9	9	2·82	W. N. W.	5	6
April	·706	·456	·592	·654	·342	·505	54·6	·428	51·5	·307	116·0	49·9	97·2	58·0	75·8	75·7	50·3	61·8	1	·45	N.	4	4
May	·691	·403	·545	·558	·294	·449	58·7	·422	57·8	·335	118·1	49·4	98·9	59·5	81·0	78·0	48·6	66·9	6	2·13	Calm.	1	3
June	·519	·316	·408	·421	·247	·333	73·1	·695	73·3	·626	119·0	65 1	101 9	72·3	83 7	80·5	64·5	74·8	15	10·06	...	6	6
July	·517	·319	·411	·424	·268	·343	74·4	·820	75·1	·770	113·5	67·1	91·6	69·3	79·8	81·6	65·5	74·8	22	29·06	...	8	8
August	·552	·319	·457	·474	·282	·372	74·3	·847	75·1	·814	110·1	69·4	89 3	71·7	79·0	79·7	69·6	74·5	26	30·31	...	9	9
September	·661	·329	·518	·566	·279	·410	71·5	·766	73·6	·726	112·0	62·5	90 5	67·1	78·6	79·2	63·2	72·6	14	18·59	...	4	6

NOTE.—The height of the barometer cistern above mean sea-level at Kurrachee is 2,232·41 feet.

Mean Velocity in miles of the winds which blew at Dehra Dún during twelve months of 1880-81 for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	2·90	2·70	2·32	3·00	3·11	2·58	3·00	2·19	1·23	1·23	·52	·36
1 „ 2	2·37	2·50	2·06	2·58	3·07	2·19	2·57	2·45	1·07	1·53	·77	·20
2 „ 3	2·27	2·30	2·42	2·58	2·79	2·00	2·67	2·23	1·03	1·53	·74	·20
3 „ 4	1·93	1·97	1·55	2·13	2·25	2·03	2·20	2·03	1·13	1·07	·42	·12
4 „ 5	1·80	1·53	1·42	1·65	2·18	1·84	2·27	1·74	1·30	·90	·52	·20
5 „ 6	1·53	1·37	1·35	1·74	1·68	2·03	2·03	1·58	·93	·80	·29	·28
6 „ 7	1·37	1·73	1·23	1·45	1·82	1·81	1·70	1·39	·93	·70	·65	·32
7 „ 8	·83	1·47	1·32	1·42	1·57	1·32	1·40	1·13	·90	1·20	·45	·24
8 „ 9	·80	·90	1·19	1·32	1·82	1·55	1·87	1·29	1·33	1·23	·81	·36
9 „ 10	1·40	1·30	1·29	1·52	2·11	2·42	2·40	2·06	1·67	1·77	1·19	·60
10 „ 11	2·00	2·07	1·71	1·94	2·39	2·58	2·83	3·13	1·90	1·83	1·65	·52
11 „ 12	2·37	2·80	2·16	2·45	2·93	3·23	3·50	3·35	2·37	1·53	1·81	·72
12 „ 13	2·68	3·20	2·45	2·84	3·46	3·81	4·70	3·58	2·83	2·07	1·87	1·00
13 „ 14	2·31	2·70	2·23	2·84	3·64	3·94	4·60	3·87	2·63	1·97	1·87	·48
14 „ 15	2·97	3·03	2·48	2·48	3·82	4·35	5·13	3·77	2·33	2·37	2·35	·92
15 „ 16	2·32	2·63	2·26	2·77	3·46	3·65	4·33	3·81	2·10	2·03	1·81	·80
16 „ 17	·97	1·40	1·32	1·87	2·25	3·00	3·90	3·29	2·73	1·43	1·13	·28
17 „ 18	·55	·50	·29	·55	·96	2·23	2·53	2·90	1·57	·90	·77	·28
18 „ 19	1·61	1·47	1·00	1·29	1·25	·90	1·73	1·55	1·53	·60	·74	·32
19 „ 20	2·65	2·73	1·81	2·35	2·11	1·61	2·07	1·26	·97	·80	·58	·12
20 „ 21	3·00	3·00	2·26	3·26	2·61	2·26	2·47	2·10	1·13	1·00	·68	·24
21 „ 22	3·06	3·07	2·19	3·19	2·82	2·71	2·97	2·26	1·23	·83	·65	·36
22 „ 23	3·26	3·03	2·58	3·39	3·07	2·48	2·97	2·32	1·00	1·03	·71	·16
23 „ 24	2·81	3·10	2·55	3·10	2·96	2·65	3·10	2·29	1·00	1·13	·52	·12
Sums	50·26	52·50	43·14	53·71	60·13	59·17	68·94	57·57	36·84	31·48	23·50	9·20
Average	2·09	2·19	1·81	2·24	2·51	2·47	2·87	2·40	1·54	1·31	·98	·38

Govt. Central Press.—No. 14 S. G.—3-4-82.—350.

Circular No. 16 S.

Extract from the Proceedings of the Government of India in the Revenue and Agricultural Department (Surveys),—dated Simla, the 8th May 1882.

READ—

General Report on the Operations of the Survey of India during the year 1880-81, submitted with the letter from the Personal Assistant to the Surveyor General, No. 1056, dated the 4th April 1882.

RESOLUTION.

THE fourth report of the amalgamated Department of the Survey of India deals, as usual, with the work of the Trigonometrical, Topographical, and Cadastral Survey parties, with geographical and miscellaneous operations, and with the work of the head-quarter offices at Calcutta and Dehra Dún.

2. The principal triangulation of all India was brought to a close during the year under review by the completion of the Northern Section of the Eastern Sind Meridional series. Outside the limits of India Proper a chain of triangles, known as the Eastern Frontier series, remains to be completed; and this work will probably be finished during the current year.

3. Thirteen separate parties were engaged in topographical work in connection with previously projected surveys. Of these, three parties were employed in Rajputana and Central India, four in the Bombay Presidency, and the remaining six in various parts of other provinces. A glance at the coloured map prefixed to the Surveyor General's report will show that the first three parties are working nearly parallel to each other from east to west across the breadth of Central India and Rajputana. The most northerly party under Colonel DePrée has advanced in its survey of Rajputana to the sandy deserts of Jeesulmir, and so devoid is the country of topographical features that a scale of $\frac{1}{2}$ inch to the mile is considered sufficient. South of this party a second is engaged on the survey of the petty Central India States, lying around Mount Aboo. The third and most southerly party has advanced out of Bhopal and Malwa, where it first broke ground in 1870, into Rutlam and Banswara. Over 24,000 square miles of country has already been surveyed by this party, and some 4,000 miles remain before the frontiers of Guzerat are reached. It will be seen from the map that in a very few years the topographical survey of the whole of Central India and Rajputana, from the Central Provinces on the east to the Punjab and Sind on the west, will be completed, and accurate maps available of this comparatively unknown and difficult country.

4. Of the four parties employed in the Bombay Presidency, one is in Guzerat, a second in Khandesh, and two others in the Deccan and in the Concan respectively. The Guzerat party has completed the survey of 14,300 square miles, and has 16,700 more to do. This survey, like the other topographical surveys in the Presidency, is being made chiefly on the 2-inch scale, and mapped both on the 2-inch and on the reduced 1-inch scale. Specimens of the Guzerat maps were exhibited at the Venice Geographical Congress by Colonel Haig, the officer in charge of the survey, and obtained the honourable reward of a gold medal. The Government of India is extremely glad to notice that in this survey Colonel Haig has been able to take much of his topographical details from the field maps of the Bombay Revenue Survey. The economy of this is obvious, and the more recent work done by the Survey Settlement Department of the Presidency approaches in its accuracy a scientific survey. The Government of India would have been glad to have had more information as to whether the other survey parties in the Presidency were equally successful in utilising the maps of the Revenue Survey.

5. In Khandesh the survey is approaching completion, as only 2,650 square miles remained unsurveyed at the close of the season. The Deccan party was

chiefly engaged in the survey of the Kaladgi District and the adjoining Native States of the Satara District. The northern half of the Deccan has now, as the map will show, been topographically surveyed, and the second party which was formerly employed there has, during the year under review, been engaged on the survey of the Concan. Good progress has been made by all the four survey parties in the Presidency, though in the Concan the difficult nature of the ground makes the outturn relatively small.

6. Topographical surveys were also prosecuted in Kohat and Beluchistan, Cutch, the North-Western Provinces, Sylhet and Mysore. The two former are important from a military point of view. In Beluchistan, Major Beavan surveyed and mapped several thousand miles of the country north of Quetta and between Quetta and Khelat. These surveys were on the half and quarter inch scales. In Kohat the smallness of the party employed told against the outturn of work for the year. The operations of the Sylhet and Cutch parties do not require particular remark. In Mysore the topographical survey of the province is being pushed on as fast as circumstances permit: 12,754 miles have been surveyed on the 1-inch scale, and 17,800 miles remain to be done, but most of this latter area has been triangulated in advance. The party in the North-Western Provinces is employed on the topographical survey on the 2-inch scale of the Gangetic Doab. It appears that for this survey the boundaries of villages are ascertained from the Revenue Settlement maps. This will materially increase the utility of the topographical maps, but the Government of India cannot but think that much of the topographical detail given in the Settlement maps might, as in Guzerat, be utilised by the topographical party.

7. The one *mauzawar* or revenue survey party, which is employed in the Punjab, completed the survey of Dera Ismail Khan on the 4-inch scale, and also surveyed some small forest areas in the Rawalpindi District. It may be noticed that the term "revenue-survey" as applied to the 4-inch surveys, which has now been practically completed in the Punjab, is a misnomer. It has no immediate connection with the land-revenue administration or the assessment of revenue, and where settlements are in progress a separate field-to-field survey is made by Provincial survey parties under the Settlement Department. The latter, it is true, are able to utilise the topographical information and fixed points of the Imperial "revenue-survey" maps, but beyond this can derive but little assistance from them.

8. Cadastral or field-survey operations were vigorously prosecuted in the North-Western Provinces and in British Burma. Of the three parties employed in the former Province, one under Mr. Johnson completed the survey of the Jaunpur District. The second under Colonel Anderson made good progress in Mirzapur; and the third under Major Barron completed the districts of Ghazipur and Ballia with the exception of 858 square miles. The survey of the permanently-settled portion of the North-Western Provinces is thus rapidly approaching completion. In Burma three parties are at work in connection with the revision of the land assessment of the Province. The largest outturn, 786 miles, surveyed on the 16-inch scale, was attained by Major Sandeman in the Hanthawaddy District. In Bassein progress was impeded by heavy jungle and the scattered character of the cultivation. In the Tharawaddy district the party was a newly formed one, and commenced work late in the season. The outturn of 461 square miles seems as much as could be expected under the circumstances.

9. The sections headed *Geographical operations in Afghanistan*, *Tidal operations*, and *Spirit Levelling operations*, form a record of very interesting work of a miscellaneous character. Geographical knowledge in Afghanistan was extended by the surveys made by Major Holdich and Captain Martin in Waziristan in connection with the Waziri expedition. Kandahar and the surrounding country was also surveyed by Colonel Leach. No less than 39,500 square miles of Afghanistan have been surveyed in more or less detail since the British occupation in 1879. The great services rendered to the army by the Survey Department have been frequently acknowledged by military authorities.

The tidal operations of the Department consist of the registration of tides at 14 ports in India, Burma and the Andamans. The observations taken at the several stations are reported to the Superintendent in charge of the operations

and furnish the basis of subsequent calculations. The instruments employed were exhibited at the Venice Congress, and obtained a 1st class medal.

The attempt to connect the mean sea levels of Madras and Bombay by a line of spirit levels carried directly across the Peninsula, was disappointing. The result makes the mean sea level about 3 feet higher at Madras than Bombay, and for reasons which are fully stated in the Surveyor General's report, the difference is considered to be due to some flaw in the levelling operations.

10. Part II of the report details the mapping and other scientific work done during the year in the head-quarter offices of the Department. The issue of a new map of India on the scale of 1 inch to 32 miles was perhaps the most important performance in the map department. It has deservedly been appreciated by the general public for its clearness and fulness of detail. A map of Southern Afghanistan in 4 sheets, and many other important topographical maps, were also published. The work in connection with the cadastral surveys was very heavy, as no less than 4,545 new maps were issued. The majority of these were executed by the photozincographic process.

11. The cost of surveys is a matter to which the Government of India cannot be oblivious. The information given in the tabular statements at pages 59-61 of the report is interesting though somewhat imperfect, as the cost of the surveys executed by the Topographical Branch is not given. In this respect the details furnished for the Revenue Branch are more complete. The cost of the topographical work done in that Branch was Rs. 25 the square mile in the Deccan, Rs. 33 in the Concan, and Rs. 31 in the Meerut Division of the North-Western Provinces. The decrease in the cost of the cadastral surveys is most satisfactory. Major Barron's party in Ghazipur have been working at the low rate of Rs. 163 per square mile, and Colonel Anderson's in Mirzapur at the still lower rate of Rs. 140. The Burma surveys are naturally more expensive, but the rate of Rs. 200 the mile, to which Major Sandeman has reduced his survey of the Hanthawaddy district, is extremely creditable to him. With these examples before it, the Government of India does not abandon the hope that the cost of cadastral work may eventually be still further reduced, and the main objection to such surveys removed. The abolition of field-books some three years ago has proved to be a most economical measure, and the testimony in favour of the present system of plotting the measurements direct on the maps, which is given by Superintendents of Survey both in Burma and in the North-Western Provinces, appears conclusive. If this one reform has increased, as Major Barron states it has, the outturn of work by one-fourth, the extreme importance of simplifying methods of work, and of utilising existing agencies, is obvious. The Government of India will hereafter deal with this subject, but it is too important to be passed over in silence in a general review of the operations of the Department.

12. The Government of India desires to acknowledge the ability with which General Walker has administered the Department during the year.

ORDER.—Ordered, that copies of the Resolution be forwarded to the Surveyor General of India, to the Local Governments and Administrations noted in the margin, and to the Foreign and Military Departments.

Madras.	Punjab.
Bombay.	Central Provinces.
Bengal.	British Burma.
North-Western Provinces and Oudh.	Assam.
	Coorg.

(True Extract.)

E. C. BUCK,

Secretary to the Government of India.

1882.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Circular No. 16 S.

Dated Simla, the 8th May 1882.

SUBJECT.

Reviews the General Report on the Operations of the Survey of India during 1880-81.

Govt. C. B. Press, Simla.—No. 115 R. & A. D.—10-5-82.—650.

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